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PROCEEDINGS
OF THE
1967
COTTONSEED PROCESSING CLINIC

Held at New Orleans, Louisiana
February 13 and 14, 1967

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Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

FOREWORD

The Agricultural Research Service of the U. S. Department of Agriculture wants to be sure that the Nation will receive maximum benefit from its research programs. Utilization research is constantly developing new ideas and products that show great possibilities of benefiting growers, industry, and consumers.

The Cottonseed Processing Clinic is sponsored annually by the Southern Utilization Research and Development Division in cooperation with the Mississippi Valley Oilseed Processors Association, Inc., to acquaint representatives of the cottonseed industry with current developments in utilization research and to provide an exchange of information that will benefit future research.

These proceedings report the statements presented by the various speakers during the 1967 Clinic and give an account of the discussions during the three sessions.

C. H. Fisher, Director
Southern Utilization Research
and Development Division

DEDICATION

This Conference is dedicated to the memory of the late Clarence E. Garner in recognition of his many contributions to the cottonseed industry and for his untiring efforts toward the success of previous Clinics.

GENERAL CHAIRMAN
R. C. Woodruff

COCHAIRMAN
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CONFERENCE COORDINATOR
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WELCOME

by

C. H. Fisher

Southern Utilization Research
and Development Division

Distinguished guests, members of the Conference: Another year has passed, and it is again my privilege and pleasure to welcome you for the Southern Utilization Research and Development Division (SURDD) and myself to this annual Clinic.

This is the 16th Clinic, and we hope and think that it will be one of the best. We, in the SURDD, look forward to these annual conferences because they play a useful function for us and we enjoy meeting with our friends. It is helpful to us and to our research to meet with representatives of the oilseed industry to exchange information and to have your views on how we can make our research as useful as possible. We are indeed grateful to have the privilege of meeting with you annually at these Clinics.

The year since our last Clinic has been busy and eventful. Some of the events of the past year have been pleasing and constructive, but at least one event has brought sadness to all of us. I am referring to the loss of our good friend, Clarence E. Garner. He was foremost among those who started the Cottonseed Processing Clinics, and he supported all of them enthusiastically and effectively. It is entirely fitting that this Clinic be dedicated to his memory.

During the past year, Aaron M. Altschul has occupied two positions, namely, that of Chief of the Seed Protein Pioneering Research Laboratory and Special Assistant to the Secretary of Agriculture for expanding supplies of protein-rich foods to meet world needs. The latter job is so important, and Dr. Altschul's contributions to it have been so great, that Secretary Freeman has asked him to move to Washington and to give all his energies to the world food problem. The transfer of Dr. Altschul represents a loss, of course, for the SURDD, but a gain for the world food program. We are proud of Aaron and we wish him every success in his new and important work.

The past year has been a busy and successful one for oilseeds research. Steady progress has been made in research to develop an understanding of and means of controlling the problems based on cyclopropenoid compounds and aflatoxins. Important basic information has been obtained about cottonseed and peanuts and their important components. New techniques have been developed for preparing nutritious flours and protein concentrates from cottonseed and peanuts. Most of this work has been done in cooperation with industry and some with the support and cooperation of the Agency of International Development (AID).

It is pertinent, also, to mention research on cotton lint because the availability of cottonseed depends, of course, upon the production of cotton lint.

We are pleased because we can report real progress in research to improve the technical and economic position of cotton lint. Probably you recall that durable-press garments, based largely on blends of cotton and synthetics, have been eating into cotton's markets for the past few years. In September 1964, the SURDD intensified its research in the area of durable press. A special Task Group has met monthly to facilitate and coordinate the work.

The results of this intensified and coordinated effort have been gratifying. About 40 research papers and patents describing advances in our work on durable press have been published. Several new methods for improving abrasion resistance of all-cotton durable-pressed products have been developed. These are:

(1) Use of improved yarn and fabric structures.

(2) Application of tough polymers to the surface of the fibers. Examples are polypropylene and some acrylates.

(3) Application of film-forming polymers that crosslink with themselves, e.g., silicones, urethanes, and polyethers.

(4) Preferential crosslinkage, that is, crosslinkage in selected regions of the fabric. This process looks most promising for corduroys.

(5) Slack mercerization and similar pretreatments.

(6) Treatments that take advantage of the helpful effect of the swelling of cotton fibers. (One of these is called "Polyset.")

(7) Use of blends of untreated cotton with treated cotton.

(8) Attachment of long-side chains to the surface of cotton fibers.

The first three of these new processes have been adopted commercially by the textile industry, and the other five are being investigated and evaluated by various textile firms.

In addition, the new carbamate finishes developed by SURDD scientists are used in the production of about 80 percent of all white durable-press products.

The successful research referred to above has been conducted in cooperation with the National Cotton Council and with several other organizations. We are grateful to them, of course, for their valuable help.

Because of these and other research advances, the durable-press situation has improved for cotton. Some all-cotton durable-press products have been put on the market. In addition, some companies have initiated the manufacture of durable-press products containing only 30 percent or 35 percent of the synthetic fiber instead of 50 percent or 65 percent. This proves again that competent processing and utilization research on cotton pays real dividends. We estimate that all research by various organizations on cotton has been responsible for saving a large portion of cotton's markets, perhaps as much as 30 percent. This is a great deal of cotton and cottonseed.

Those of you who have looked recently at the southern side of our Laboratory on the Lakefront probably noticed the construction work on a new building. This new building, which should be ready for use next September, will house two pilot plants for processing cotton. One of the pilot plants will process cotton mechanically, whereas the other will be used for the chemical or wet processing of cotton. We are looking forward to having these new facilities because they will increase our potential for doing research helpful to cotton and cottonseed.

I would like to express appreciation to everyone contributing to the success of this Conference. I wish to give special thanks to the officers of the Mississippi Valley Oilseed Processors' Association, our General Chairman, Session Chairman, speakers, and staff of the Southern Utilization Research and Development Division for the arrangements that have made this Clinic possible.

We have an excellent program before us, and I hope that your stay in New Orleans will be enjoyable and rewarding. Thank you.

OPENING REMARKS

by

George H. Dunklin, President
Mississippi Valley Oilseed Processors
Association, Inc.

On behalf of the members of the Mississippi Valley Oilseed Processors Association, which I have the pleasure of representing today, I want to express again what a very pleasant privilege it is for us to renew our participation with you and your distinguished associates in this annual Cottonseed Processing Clinic.

Our ties with your organization have been close for many, many years, and it is indeed most gratifying to see this continuing cooperation between our two groups.

Certainly this is an event that all of us look forward to with keenest interest, and we are indeed grateful to you and your staff for your fine and always successful efforts to present such informative and productive programs.

In reflecting on some of the problems and questions that face our industry, many of which will be discussed during the course of this clinic, I am reminded of the story about an economics professor who was informed that the copies of all of his examinations for the previous years were being circulated freely on the campus as finals approached.

"Oh, that's all right," he said, "The questions always stay the same. It's only the answers that change." I couldn't help but think how appropriate this remark was to this clinic. So many of the questions that will be brought up here today have been asked many times before and will be asked many times again in future meetings. The answers we hear today and tomorrow will represent the latest progress that has been made in research and the availability of increased knowledge and technology that is constantly changing the entire complexion of our industry and the products it produces.

Nothing is more certain than that we may continue to expect even more changes in the cottonseed processing industry. Some of these changes will be violent, rapid, yes, even frustrating and confusing, but above all, exciting and challenging.

All of us are acutely aware of the ominous problems that confront us, as evidenced by the constantly declining number of mills, the precarious economic status of cotton itself.

Admittedly, we cannot solve these economic ailments here today and tomorrow, but we can examine some of the progress that has been made in research and technological improvements in our products and our manufacturing procedures and greatly profit in the process.

The very fact that we are here today attests to our own firm faith in the continuing importance of our position as cottonseed crushers and our optimism about the present and future role we hope to play in our Nation's agricultural economy.

A great deal of thought and hard work has been put into planning and organizing the fine program that is about to begin. I am sure that I speak for all of you when I express to Dr. Fisher and all of his staff, our general chairman, Ralph Woodruff and his committee, and our esteemed association secretary, Tom Allen, our deep and sincere appreciation for your splended efforts in our behalf.

SESSION I

John H. Adams, Chairman

POTENTIAL OF OILSEED CROPS AS A PROTEIN SOURCE OF WORLDWIDE HUMAN NUTRITION

by
Aaron M. Altschul
Southern Utilization Research and Development Division

I cannot think of a better way to start a new job than to speak to a group of old and close friends as those in the cottonseed industry. You all know what I think of the industry and its people and of the associations which it has. In my opinion, there are no better members and officers of associations than in the cottonseed industry. The industry is aggressive, active and looking forward. I also appreciate the opportunity to speak in the presence of people who have been guiding my efforts for so many years, Drs. Fisher and Senti.

Mr. Dunklin's opening remarks set a stage for what I think ought to be a serious discussion of where cottonseed stands and where it is going. Perhaps I can contribute something by putting the story of cottonseed in the perspective of some other stories.

In the last year, as Dr. Fisher mentioned, I was on a special assignment for Secretary Freeman to help accelerate efforts to develop new sources of protein, low cost sources of protein.

We all recognize that protein malnutrition is second only in seriousness as a world problem to total food supply itself. If there is not enough food, then there is no use worrying about the kind of food eaten. Even if there is enough food but not enough protein, this constitutes a serious public health, medical, social, and economic problem. It is obvious that the animal sources of protein--be they milk, eggs, or meat--are not going to be adequate in quantity to supply all of the good protein that is needed; the additional supply must come from other sources made available by technology.

Our effort this year was to stimulate the private sector of the American Food Industry to put its expertise at the service of this problem, but as part of a private enterprise effort, that is, to establish food industries in the countries where there is a protein shortage. Our effort was in two directions.

The first was to improve the protein impact of the cereal grains. There are roughly 82 million tons of protein available now in the world. Of these 82 million tons--I am talking now on a pure protein basis--25 million tons are supplied by animals, 40 million tons are supplied by cereal grains; and about 12 million tons are supplied by legumes and nuts.

The cereal grains are the major supplier of protein; anything that can be done to boost the protein quality of the cereal grains makes a major contribution.

We are interested in two ways of doing this: (1) by adding synthetic amino acids and (2) by adding small quantities of protein concentrates sufficient to improve them, but not excessive enough to change their character.

The second approach is to develop the protein foods. In the last year we saw over a hundred food companies. We received a number of proposals for projects to develop new food industries in various parts of the world. We worked very closely with the Agency for International Development in the State Department to develop organizational and financial mechanisms for stimulating these companies. The first of these mechanisms was announced in the "Commerce Business Daily" on February 2.

The State Department and the Department of Agriculture are willing, in this particular program, to help food companies study a market in a particular country; find out what kind of a protein food will sell; go into their own laboratories and design this food, build a prototype and then test-market it.

This program is now under way, or will be, in a week or so. The first contract will be signed, I believe, next week. Several others are expected to be signed within a month. What kind of products and raw materials are we talking about?

We are talking about beverages. It would seem that, in this day and age, with the technology now available, every child in the world ought to be able to drink a protein beverage. If he is lucky and can afford it, he can have milk; if he cannot afford milk, he ought to be able to have another protein beverage instead. Everybody has been excited and stimulated by the performance of a soy protein beverage in Hong Kong called Vita-Soy, which outsells the soft drinks.

Various kinds of soft drinks are being thought of: Packaged soft drinks that are added to water, fruit drinks, and bottled drinks such as this Vita-Soy.

Other kinds of products being considered are fortified cereals, soy protein products of various textures, and protein concentrates, for example, from wheat milling byproducts. We have available a full spectrum of food products ranging from the most sophisticated textured products, spun products that look, chew, and can be eaten like meat, to plain cereal protein mixtures that can be eaten in gruels and soups.

We realize, of course, that nutrition is just one part of this story. The food has to be nutritious, and we know this is possible.

That is just part of it. The food also must be desirable. The food must be eaten, because a mixture is not a food until it is eaten. We belive that the technology is now available to develop those foods.

What are the raw materials? Soy is the most popular. I did mention wheat milling byproducts in one of the proposals; all of the studies mentioned that cottonseed would be considered along with others. But we do not have, at this moment, a single proposal that starts with cottonseed as the first choice. This is so even in places where there is cottonseed and there is no soy.

I should recite my experience in India, and I expect that Dr. Senti had the same experience. We talked to a number of industrialists, operating in India who are interested in developing food products there and asked them what they would like to start with; they all would like to start with soy. Then, we reminded them that there are no soybeans in India. "Well, we will grow them." "Are you sure you can grow them economically?" They were not so sure, but that is what they would like to start with. We reminded them that there are ample peanuts and cottonseed in India, but they would like to try soy first. This, despite the fact that probably the best known of the new protein food products in recent times for its success nutritionally and for its commercial application is Incaparina in Central America, is a cottonseed product. It contains just a little bit less than 40 percent cottonseed protein concentrate and the rest corn. It has the nutritional capability of doing the job, and is selling in Guatemala and Colombia.

I suppose it is proper to ask why cottonseed is not the number one choice of some of these companies in areas--I mentioned India, but the same would be true of Africa and parts of Latin America--where cottonseed is available. There are probably many reasons. I can think of four.

Perhaps the first reason is unfamiliarity. There just is not enough soy around so that people have a chance to look at it and try it. Everybody is excited about the soybean drink in Hong Kong, so there is talk about soybean drinks in India. Soybean is very familiar in Hong Kong; it is unfamiliar in India, yet the fact that it is familiar in one place gives people more confidence to try it in other places as well.

The second reason might be color. I think the color that cottonseed flour adds to baked products, for example, or color that people might be concerned with in beverages, is a factor. Although it may not turn out to be a problem, they anticipate that it might be one.

Third, is the lack of information about the fact that gossypol can be handled in present processing techniques to a satisfactory degree. I think this slows people down. I think there is a problem of education.

Fourth, perhaps might be the relationship to cotton lint and the concern about future supplies.

It might be the fact that cottonseed is not so popular as a source of protein for humans and that it is not terribly important to the industry. I was told that cottonseed meal prices currently are quite high. One might properly ask, "Why should anyone worry about anything else if you can get a high price for cottonseed cake?" I would think that while things look one way from where I stand, they might look entirely different from where those of you who have to pay the bills look. And you might come to another conclusion.

One thing is clear: Whatever happens to cottonseed in the future depends on what you people think and do. I would like, in general, to talk about three options.

You can decide to confine cottonseed protein concentrate primarily for cattle, as it now is. You will have to try to guess what the growth rate of the urea development will be and how it will influence your markets in the future.

If you wish, you can, as a second option, prepare protein concentrates for all kinds of animals, including monogastric animals. I would expect that you would have to follow carefully the development of competitors. You might want to look closely now and then at the development of high-lysine corn which will change, if it progresses as people expect it might, the amount of protein concentrate that will be required in certain animal feeds.

Of course, the third option would be that you play the whole field and try to get cottonseed protein concentrate into human food as well as for livestock.

I don't know what your feeling is. It has to depend on your own interest. I know my feeling. I know, as a matter of fact, that Incaparina, which is a mixture of cottonseed protein and corn protein to which lysine is added, is as good a source of protein as casein, the protein from milk. It is a fact that cottonseed protein can be as good as casein when properly handled and mixed with the proper additives.

You have to make the decision, but I would like to make a suggestion, and I make this suggestion very easily, because I do not know anything about this subject. There now exist mathematical procedures whereby one can analyze the options and the effect of choosing the various options. All of us tend to operate too much by the seat of our pants. It seems to me, with the availability of these mathematical systems, one does not have to do that. In our own field we are toying with the notion of trying to develop a systems analysis of food supply and of trying to work out the lowest cost approach for humans that might give us an opportunity, in every instance, to decide which of the options are available.

The cottonseed industry, as an industry--perhaps some of you in your own organizations have already done it--might wish to take a look at the systems analysis approach of the options, just as many of the American industries now regularly do in any of their new ventures. You might want to know what the effect quantitatively is of the trends and markets for cotton lint and the effect of research on cotton lint as pointed out by Dr.

Fisher. You might try to analyze the effect of urea or of high-lysine corn. You might try to figure out what can be done now with cottonseed protein concentrates as presently made and what we can expect from future research. How important is it to encourage glandless cottonseed, and how fast are fish protein concentrates and proteins from petroleum becoming available?

You will still have to make the decision, in the last analysis, but at least you are entitled to have the best possible facts and projections as a basis for making this decision.

I would like to conclude on, perhaps, a sober note. It seemed to me, up until very recently, that it was clear that cottonseed would eventually get to its optimal use. If it had the potential of being a protein as good as casein, such an option would be realized. It might come faster or slower depending on how you people encourage it, but it was going to come about. I think I was wrong. I do not think that anything comes about automatically. We have, in our talks of new sources of protein, always classed the oilseeds as the number one new source, and we have always included cottonseed among them. In recent years, two major competitors have arisen and they may displace some of the sources. I am talking, first, about fish protein concentrate, which has gotten an enormous boost in the last few weeks.

The fact that fish protein concentrate can be fed to humans in the United States is important for what it does for feeding humans outside of the United States. It now releases an enormous research energy to try to make it available all over the world. It certainly is a source of protein that has to be reckoned with.

I do not know how many of you ever heard a year ago of proteins from petroleum. They can now ferment hydrocarbons of various sorts to produce single-cell organisms that are a good source of protein. An enormous amount of money is being spent on it; I would say manyfold the amount of money that is spent on cottonseed research, by practically every oil company in the United States and elsewhere.

They have made so much progress that this fall there is going to be a conference on this single subject alone. I do not think that this is an immediate source of protein, but I would not want to predict how long it will take until it becomes a viable source of protein. The amount is there; the quality is there; they have to get the cost down. Here are two sources of protein that have come to the forefront recently.

Years ago, if you talked about new sources of protein, people would ask, "What about algae?" Algae certainly were things that people talked about. You do not hear as much talk now about algae; you talk about petroleum and fish proteins first.

That does not mean that algae are not good sources of protein. These others have displaced algae. I would think that any source of protein is not secure in the face of accumulating technological advances. Those of us who have the job of providing more protein do not care where it comes from. But you do, and, therefore, it's up to you to take a critical look at where you expect cottonseed to be in the years hence.

At this particular time I think the matter is still in your hands. There are still many options to investigate and develop.

DISCUSSION

Question: These proteins you mentioned being potentially extractable from hydrocarbons, is that a protein similar to the type that comes from urea? Will this be something that is a potential competitor to the proteins in our cottonseed meal such as urea has been?

Dr. Altschul: No, these are micro-organisms like yeast. These people have decided since they are spending considerable money on research and development, it will go directly for human food. Therefore, these will be competitors for human food protein.

Question: Would you class the work being done with fermentation with the growing of protein on cellulose in this same general field?

Dr. Altschul: Yes, I'd think that what you might call single-cell organisms, whether the substrate is a hydrocarbon like petroleum, coal, or gas, or whether it is a carbohydrate like cellulose, are all in the same class.

OILSEED RESEARCH IN THE AGRICULTURAL RESEARCH SERVICE

by
Frederic R. Senti
Deputy Administrator
Nutrition, Consumer and Industrial Use Research
Agricultural Research Service, USDA
Washington, D. C.

As in all agricultural research, our purpose in working on utilization of oilseeds is to maximize the efficiency of use of our agricultural resources, to make needed products at lesser cost, or to make better and more useful products available. The oilseeds are perhaps the most versatile of our farm crops in respect to use. They are much alike but by no means interchangeable. In the competitive markets for foods, feeds, and industrial products, each must be handled and processed in accord with its own special characteristics. Each has its special advantages and its own problems. Oilseeds included in our research are soybeans, flaxseed, cottonseed, peanuts, safflower, castor, and crambe--a crop just emerging from our new crops research program.

The increasing U. S. soybean crop reflects today's burgeoning use of oilseeds, particularly in the world market. As the economies of Western Europe and Japan have grown in recent years, the demand for meat and especially poultry has skyrocketed. The demand for oilseed meal to produce this meat has resulted in an increasing demand for U. S. soybeans and oilseed meals.

As income around the world continues to rise, we can expect the demand for both oil and meal to continue to increase.

Perhaps, today's most intense interest is focused on the critical problems of the approaching crisis in world food supply. Actually food shortages have existed in parts of the world for a long time. With rapid increase in population, especially in the past decade, this shortage has been accentuated. Deficiencies in calories and proteins exist in many countries in Latin America, Africa, and Asia. The protein shortage is especially serious for weanling infants and preschool children because of their relatively greater requirements for protein per unit body weight. This deficiency is manifest in the disease called kwashiorkor, common in many of the less developed countries. It is generally agreed that protein malnutrition lowers resistance and increases the death rate from childhood diseases. Though major contributions can be made through other commodities, the oilseeds constitute the ones that are in the best position to alleviate this need now. There are problems in their utilization though and we are looking toward solutions for those that can be defined today.

The first of these is the problem of supply. Cottonseed is produced in a great many countries--India, Egypt, Latin America, Pakistan--but only a fraction of the seed is processed, and very little of the processed seed is made into an edible product. Peanuts are crushed for oil in India but the meal is not an edible product and is used for cattle feed or fertilizer. Aflatoxin is a major problem in processing for edible use. We are working with the Agency for International Development (AID) to adapt methods that have proven successful in this country to their processing under conditions that exist in the developing countries. At the same time, we are working to make available better varieties, to improve the quantity and quality of their protein, and to adapt their physical characteristics to the type of processing required, as well as to maximize yields.

The first problem in consumption of the oilseed proteins is that of presenting them to the prospective consumer in attractive palatable nutritious forms. We have work in progress or recently completed in each of several areas. One of the products I would like to tell you about is the one we call CSM which means corn, soy, milk. It is made up of the following per 2, 000 pound batch:

Ingredients	Lb. per 2,000 lb. batch
Cornmeal, processed (gelatinized)	1,361
Soy flour, defatted (toasted)	500
NFD Milk, spray dried	100
*Calcium phosphate, dibasic, hydrated FCC grade $CAHPO_42H_2O$	11
Mineral premix	26
Vitamin antioxidant premix	2
	2,000

*May be part of mineral premix, if desired

Processed cornmeal is a cooked product and the CSM mixture readily forms a dough with water or is suspended in water to form a gruel or beverage. The product is well accepted by children and they do very well on its balanced proteins and calories. The Commodity Credit Corporation (CCC) has purchased 150 million pounds of it and we anticipate that purchases will continue indefinitely so long as the need exists. Cottonseed meal might well be used equally in such a formulation with only the formula adjustments needed to conform with its slightly different amino acid makeup if good food grades were made available. Flours from hexane extracted meals processed under conditions to give low free gossypol content and low fiber, yet minimizing protein damage might be used in these cereal-oilseed blends. Superior products from viewpoint of protein value and color would result if processes for pigment removal were developed. Henry Vix will discuss progress made in research at the Southern Regional Research Laboratory on development of such processes.

Returning for a moment to soybeans, engineers at our Northern Utilization Research and Development Division have developed a simple hand process for producing full-fat soybean flour in villages and rural areas of developing countries. Soybeans are soaked overnight, boiled 10 to 15 minutes, air-dried, cracked, dehulled, and ground. All that this processing requires is an open fire and human muscle. Cracking, dehulling, and grinding are accomplished with simple, inexpensive, commercially available machines designed for manual operation.

Flours made by the hand process compared very favorably with commercial samples. Beverages prepared with the experimental flours showed good dispersion stability for 24 hours or longer. In a study of bacteriological and oxidative stability, samples of full-fat flour prepared by the hand process were stored 40 weeks at room temperature. Microbial counts remained very low during this period. Taste panel evaluation showed no rancidity or off-flavors. Peroxide value at the end of the test was lower than that of soy flour made by a conventional process.

The area of domestic food uses of soy meal products is one of great and increasing interest. At our Soybean Conference at Peoria last October, Dr. W. W. Meyer, of Central Soya, gave us an excellent discussion of the protein concentrates and isolates that enter into these uses.

We are conducting significant research looking especially to the physical, chemical, and physiological properties of the individual soy proteins and to the flavor components of the meal or flour. One property of interest is the gel forming characteristics of the isolated proteins. It appears that this property and that of emulsifying fats and moisture binding are important in the specialty uses of these products. We have not undertaken research on the development of the so-called meat analogues from seed proteins. We do recognize the meat analogues as products of surpassing interest and recall in this connection our early work on the spinning of protein fibers which resulted for a while in the commercial production of Vicara.

Peanut Research. --As a result of another of our projects, partially defatted peanuts can now be prepared by a new process without the use of solvents. Whole raw or blanched peanuts are mechanically pressed until most of the oil is removed; they are then expanded to their original size by heating in boiling water; the expanded peanuts are then dried and roasted with or without oil. This new product contains about one-third the oil of conventional roasted peanuts. With the removal of the oil, the percentage of each of the remaining constituents is correspondingly increased. Thus, the percentage of protein in the extracted product is much higher than in the original peanuts. These peanuts have the shape of conventional roasted peanuts and closely simulate their texture, flavor, and aroma. The process works equally well with all types of peanuts--for example, Spanish, Runners, and Virginia. At least seven U. S. manufacturers about ready to put the product on the market.

There is one other problem in use of oilseed protein of which I should speak. Several years ago, it was observed in England that a certain mold known as Aspergillus flavus growing on peanut meal could elaborate a substance extremely toxic to turkeys. The toxic substance was named aflatoxin from its origin, and intensive research soon disclosed its chemical structure and methods for its detection and estimation. Further investigation has shown that similar toxins are produced on cereal and oilseed substrates by A. flavus and certain other molds. It has disclosed, too, the conditions of moisture, temperature, and otherwise, under which they are elaborated. Our laboratories have contributed heavily in this area and we are continuing to search for means for removing the toxin or better for means of preventing its development. Reports on our research will be given later in this conference by Frank Dollear of the Southern Utilization Research and Development Division (SURDD) and Alex Keyl of our Western Utilization Research and Development Division (WURDD).

Research looking to more efficient production and distribution of feeds is carried on in all of our laboratories. Better processing of cottonseed meal based on research at SURDD and in the industry has resulted in the use of three-quarters of a million tons in rations for poultry and swine. The gossypol problem in cottonseed meal, of course, has been an important one in the Southern Regional Research Laboratory. Not only does the gossypol have a deleterious effect on nonruminant livestock but it contributes to the loss of lysine when the meal is produced by conventional processes. Lysine is one of the critical amino acids in livestock production, and relatively less plentiful in cottonseed meal than in many competing oil meals. Also, feeding cottonseed meal containing free gossypol to laying hens can result in discolored egg yolks, and feeding it to hogs may result in toxic effects.

The approaches so far have been to remove the gossypol and to neutralize the effects of it by additives. The acetone-hexane-water process has successfully removed sufficient amounts of gossypol to make the meal suitable for monogastric animals and it accomplishes this with minimal protein damage. Iron and calcium compounds have successfully neutralized the gossypol, too, though optimum amounts are still to be determined. Cottonseed meal suitable for poultry and swine feed will find a wide market and one in which it is not directly in competition with urea as it is in ruminant feeds. If the glandless varieties of cotton can be adapted in respect of such characteristics as yield and fiber quality, then another solution of the gossypol problem will be available.

Castor Meal Research. --The castor bean may some day be an important crop in some areas of the United States. The oil it produces has very interesting possibilities beyond its traditional use. Of 150 million pounds used annually, we produce about 26 to 28 million pounds. It may find substantial application in the plastics industry but to allow its economic production here, two problems must be solved. The meal contains the toxic protein, ricin, and it also contains a potent allergen, perhaps the most potent known. The protein can be detoxified rather simply but the allergen has presented a difficult problem only now being solved on a commercial scale. This work led us deeply into fundamental immunochemistry and a number of contributions to that complex science were made in the course of it.

Soybean Oil Research. --Research on food uses for soybean oil continues to concentrate on improved stability. Recalling the slides which showed our expanding overseas markets, it is of interest to note that most European margarines are made without hydrogenation and consequently require stable oils. Our work has resulted in products stable enough for use as cooking oils, and it is continuing to show further improvement. Selective hydrogenation to remove linolenic acid shows promise of solving the problem.

Nonfood Uses of Vegetable Oils and Fats. --For nonfood uses, Americans make industrial oil products from flaxseed, soybeans, castor beans, cottonseed, coconuts, palm kernels, tung nuts, and doubtless others. Collectively, this represented about 2.6 billion pounds in 1964 with which should be noted an additional billion pounds of tall oil and nearly 1.7 billion pounds of inedible tallow and greases.

Our laboratories are continually seeking new economic outlets for oils and fats in industry. The field of polymers is the one that appears of greatest promise, including as it does the large markets for surface coatings, plastics, plasticizers, lubricant additives, and a host of others.

A few decades ago, agriculture supplied most of the raw materials for many of them, including linseed oil, leather, and tung oil. Petroleum-based synthetics have invaded them in recent years and competition from these products of low and stable price has been very keen.

For example, there are among the ingredients of the 600-million-pound alkydresin market a number that are or can be delivered from oilseeds, namely, glycerol, and the various saturated and unsaturated fatty acids. The introduction of oil-modified alkyds about 40 years ago led to rapidly expanding outlets for seed oils in the paint and varnish industry. However, in the late 1940's a new class of paints--the water-based paints produced by emulsion-polymerized dispersions of styrene-butadiene copolymers and other petroleum derived synthetic polymers--were introduced. Where applied to a surface, the water evaporated and the dispersed particles of the so-called "latex" base coagulated to form a continuous resinous coating. The success of these convenient and fast drying petroleum-based paints resulted in decreased demand for drying and semidrying oils such as linseed, soybean, castor and dehydrated castor, tung, and safflower. Quite naturally, this led producers of solvent-based paints to devise methods for emulsifying the oil-modified alkyd resins. We have been, and still are, cooperating in these developments in order to reverse the trend that saw the demand for linseed and other seeds fall steadily during the 1950's.

As a result of recent research, we have developed a number of new coating products. One of these is an ionic emulsion paint formulation based on linseed oil. This paint is viscosity stable, dries tack-free in an hour, passes the water test after 15 minutes, dries to a hard film on glass in 20 hours, and shows no wrinkling, blistering, or other visible change after soaking in water for 24 hours. Already, these paints have utilized the equivalent of 5 million bushels of flaxseed.

There are markets in coatings for very substantial quantities of agricultural materials if we can prepare from them products having improved durability. Application is one of the major cost factors and better durability would reduce it proportionately.

In a related field of interest, our Northern Utilization Research and Development Division (NURDD) has been investigating the possibilities of linseed oil for coating concrete. As a result, boiled linseed oil is being used by an increasing number of states, for a total consumption of 25 to 30 million pounds to date. Indeed Illinois now uses it on all new concrete highways as an anti-spalling agent to protect against damage caused by freezing and thawing. Widespread experimental use of an NURDD-developed, water-based linseed oil emulsion that will help to avoid loss of moisture from freshly laid concrete during curing is under way in many states. It is expected that this treatment will also protect against spalling action for the next year or two. This has led to industry estimates that fully 50 million pounds of linseed oil annually could go into anti-spalling compounds for new roads, and 100 million pounds annually for the treatment of older surfaces, bridge decks, sidewalks, and other industrial uses.

Castor Oil Research.--Another example of our work is in the polyurethane family of polymers which are being produced in the forms of solvent and 100 percent solids type coatings; flexible, semiflexible, and rigid type foams; and casting compounds and elastoplastic-type resins. Each type involves the reaction of a polyisocyanate with compounds containing reactive hydrogens such as polyesters, polyethers, castor oils, amines, and carboxylic acids. The 1965 market for flexible urethane foams amounted to 230 million pounds, the rigid urethane foam market to 75 million pounds, the elastomer market to about 8 million pounds, and the coatings market to about 12 million gallons.

Castor oil is frequently employed in urethane coatings. We have found this hydroxy-containing oil slows down the drying speed and increases the flexibility of urethane coatings, and improves their water resistance. Foams based primarily on castor oil polyols are semirigid at low density and become more rigid as the foam density increases. The rigid and semirigid polyurethane foams are valued by the refrigerator and the building construction industries primarily for their high insulating efficiency, their excellent shock-absorbing properties, and good low-temperature flexibility. Research in Agricultural Research Service (ARS) today is concerned with the problems of imparting greater fire resistance to foamed-type insulating materials, the production of closed-cell walls impervious to such blowing agents as the fluorocarbons.

Safflower Research.--Among the newer oilseeds, we are working to make safflower a profitable crop. New varieties, especially those having thinner hulls, are being developed by the Crops Research Division. The feeding value of the meal is being studied so that this potentially valuable byproduct can profitably be sold to feed mixers. There is a growing market for the oil in foods and in drying formulations. Its high content of linoleic acid renders it a likely candidate for the preparation of useful chemical derivatives not as economically available from other oils. Among the new varieties being developed, there occurs substantial variation in oil composition. Some contain as high as 80 percent oleic acid.

Crambe abyssinica is a potential new crop which produces an oil containing a high proportion of the fatty acid known as erucic. This property suits the oil for a number of industrial purposes from a plastic raw material to a highly specialized lubricant. We are well on the way to learning how to process it. In cooperation with other Department agencies, we are seeking to make it yield at a profitable level and ways to increase the erucic acid content of the oil. The oil is especially promising as a lubricant in the newly developed continuous casting of steel and this outlet alone may eventually consume as much as 40 million pounds.

Summary

The purpose of utilization research on oilseeds is to make from them needed products at lesser cost or to make more useful products. Oilseed researchers which are particularly promising in terms of potential benefits have the following goals:

1. To make oilseed protein available to consumers in attractive, palatable, and nutritive forms.

2. To discover economical methods of eliminating toxins from or preventing their development in oilseeds and oilseed meals.

3. To lower the costs of producing and distributing manufactured feeds by eliminating deleterious substances in oilseed meals.

4. To improve the stability of soybean oil.

5. To show how vegetable oils can be an economical raw material for polymers used in coatings, plastics, etc.

DISCUSSION

Question: You did not say anything about sunflower oil; I understand that it is developing into quite an industry in Russia. Also, years ago, I used to hear a good deal about tung oil; you didn't mention that. Do you think there is much prospect for either of those in the United States?

Dr. Senti: Sunflower oil, as you mentioned, is the principal vegetable oil of Russia. About 1959, there was much interest in this country, so we did considerable experimentations with analyzing it in the regional laboratories, but it lost out in competition with soybeans, yieldwise, disease resistantwise, I mean agronomicwise, and probably by the rapidly increasing demand for livestock feed, which was furnished by soybeans better than by sunflower. There is interest again in sunflower seed, particularly in our northern states--Minnesota and the Dakotas--where it conceivably could compete well with existing crops.

Referring to tung, some problems beset it. If something could be done to take care of the problems, again, of agronomics, to make it a profitable crop; to solve this problem of freeze resistance and insure a regular crop; tung would be in a much better position, I think, to compete in our markets.

Question: My question is just a little bit different from the subject we have been hearing about today and will be hearing about possibly tomorrow and the next day. Will the effort be decreasing the death toll on the roads by automobiles? I just wonder if putting this oil on the concrete, particularly bridges, will make the road surface slicker?

Dr. Senti: Attention is being given to the problem of slipperiness; I can't give you the exact figures on it, but the time for it to dry and to restore the coefficient of friction to original values after application are set by the Highway Commission as the safe values. It's a relatively short time, within the order of a day or so, that linseed oil dries and the frictional coefficient restores.

Question: After it dries and then it rains, what happens?

Dr. Senti: Once it dries, a subsequent rain doesn't affect the coefficient of friction.

PROBLEMS AND PROSPECTS OF COTTONSEED FLOURS FOR FOOD USE

by
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Southern Utilization Research and Development Division

"Cottonseed Meal as Human Food" is the title of Texas Agricultural Experiment Station Bulletin No. 128, dated March 1910.

During the last 56 years, since issuance of this bulletin, there has been produced in the United States a total of over 317 million tons of cottonseed; 268 million tons were crushed from which nearly 125 million tons of meal were produced.

In 1910 hope was expressed to find use for cottonseed meal as human food. Very little of the tonnage produced over the years actually found use in food channels.

We all know and are familiar with the problems that arose, which limited cottonseed meal principally as feed for cattle.

As the years progressed, research in technology and engineering made many improvements in processing of cottonseed. Through these improvements and the diligent efforts of the National Cottonseed Products Association (NCPA) and other trade organizations much advancement has been made to achieve full utilization of the oil and meal products from cottonseed.

Cottonseed oil has enjoyed wide utilization in many food items. Today, cottonseed meal is finding increasing use in practically all feed channels.

Today, however, we are again focusing attention on cottonseed flour as a potential food product. Why is this? As Dr. Altschul has already brought out that the world is in urgent need of protein. In the developing countries particularly, much hunger and starvation prevails, although in some of these countries protein exists in the form of oilseeds such as cottonseed. The situation will become more acute and graver in the immediate years ahead. There is a population explosion occurring in many parts of the world--particularly in the developing countries. It is estimated that the world population of today will double by the year 2,000. This means an increase from 3-1/2 billion to nearly 7 billion people.

Today, the world production of the three principal oilseeds are as follows:

	Million tons
Soybeans	34
Cottonseed	24
Peanuts	18
	76

This represents many millions of tons of protein. Looking at the fact that cottonseed represents over 30 percent of the available protein from these three principal oilseeds, one quickly realizes that cottonseed meals or flours could be a source of a highly acceptable food--a protein food for hundreds of millions of people.

This is further illustrated in table 1.

In this table are given the essential amino acids and the amounts as established by Food and Agriculture Organization (FAO). One quickly sees that cottonseed practically meets the FAO requirement. Its principal deficiency is in methionine. Perhaps this could be supplied through supplementation.

Today, many people in this country and in many government groups, such as Agency for International Development (AID), our own Agricultural Research Service (ARS), the United Nations Children's Fund (UNICEF), and others are actively engaged in research and promotion programs to aid developing countries in using oilseed flour and other agricultural products as food to meet their urgent requirements. The hope is that in the end we can help these people to feed themsleves. Thus, our own interest, in this country, in developing cottonseed flour as a food is not so much for our own immediate need, but to be produced by these developing countries for their own use.

The question one must answer is whether, with our present technology and engineering, as practiced by the U. S. Cottonseed Industry, a food grade cottonseed flour can be produced--one that is acceptable to be mixed or blended with grains and other food materials for preparation of foods for the World Food Program.

Table 1. -- Essential amino acids of proteins (g./100 g. protein)[1]

Amino acid	FAO reference	Skim milk	Cottonseed	Peanut	Soya
Lysine	4.2	8.6	4.1	3.0[2]	6.8
Tryptophan	1.4	1.5	1.2[2]	1.0[2]	1.4
Phenylalanine	2.8	5.5	4.7	5.1	5.3
Methionine	2.2	3.2	1.6[2]	1.0[2]	1.7[2]
Threonine	2.8	4.7	4.7	2.6[2]	3.2
Leucine	4.8	11.0	6.6	6.7	8.0
Isoleucine	4.2	7.5	3.7	4.6	6.0
Valine	4.2	7.0	5.3	4.4	5.3

[1] Table taken from "Peanuts as a Protein Resource in International Feeding Programs," by Max Milner. Food Technol. 16(7): 46, 48-50, 52-53. 1962.

[2] Limiting amino acid.

Conservatively speaking, one can state that, with certain modifications, some of the U.S. oilseed mills could produce a flour that no doubt will find acceptance. Sanitation and other standards, as set by food industry and government and adequate milling and packaging requirement, need to be satisfactorily solved.

I believe we are all acquainted with the commercial efforts under way in Central and South America in which cottonseed meal is being used in food formulations. Incaparina formulations include 38 percent cottonseed meal. It is being used in Central America, particularly Guatemala and Panama. It is being sponsored by the Institute of Nutrition of Central America and Panama. Children have been fed this product in carefully controlled tests, some of which were continued for a full year. No detrimental effects were observed. It has been reported that sales of Incaparina will total 4,500,000 lb., an increase of 32 percent over the previous year. In Colombia and Venezuela, an Incaparina product is being marketed. (Sample shown to audience).

Peruvita, a high protein food product is being marketed in Peru. Two types of Peruvita are produced--one salted and one sweetened--consisting, respectively of 56 percent and 50 percent cottonseed flour.

This breakthrough in Central and South America is paving the way for further use of cottonseed flour in food formulations.

Trader Oil Mill, Fort Worth, Tex., has marketed their "Proflo," a food grade cottonseed flour product, for some years. It has found some use in this country, particularly in bakery products where a small percentage is used. I believe that this flour meets all the specifications set by UNICEF for a cottonseed flour.

Some of the other U.S. cottonseed oil mills feel that they can make necessary changes in their processes to meet requirements for producing food grade cottonseed flour, particularly for use in the World Food Program. They are currently studying the problems associated with this endeavor.

We believe that advancements and results in both processing and product quality stemming from our current research at SURDD will ultimately find wide use.

Let us look at some of the problems that require attention before cottonseed can be used widely to produce a highly acceptable flour--one of maximum quality.

1. To produce high-grade protein flour, only prime, mature, sound oilseed, free of contaminants should be used.

2. A plant for production of food grade flour should be an integral part of a larger plant designed to produce feed grade meal also. In order to produce flour of 55 percent protein or higher, and for other quality

considerations, it will be necessary to divert part of the meat's stream to a second processing line which would produce feed grade materials. In the case of cottonseed, through such provisions, it will be possible to produce 300 to 400 lb. of 60-percent protein food grade cottonseed flour from a ton of seed.

3. For cottonseed, the main concern over the safety of cottonseed products in human diets is caused by occurrence of gossypol in glanded cottonseed. Many are of the opinion that the gossypol content, both free and total, should be extremely low so as to maintain maximum quality meal and to rule out any adverse physiological effects upon humans in the prolonged use of cottonseed flours.

4. To achieve maximum benefit from a nutritional standpoint, it is desirable for processing to yield a final flour which approximates the protein quality present in the original seed.

5. It is preferable that the flour have less than 1 percent residual lipids to insure quality of the product upon prolonged storage.

6. It is desirable to have a protein content as close as possible to 60 percent. This results in a low fiber content in the flour--3 percent or less.

7. The product should be free of mold contaminants that adversely affect its quality.

8. The flour should have no objectionable odor. In fact, it should possess an acceptable flavor, as judged by U. S. standards, or the standards of the foreign country in which it is being utilized.

9. The protein flour should be finely ground so that essentially all passes a 200-mesh screen. It should have the right texture.

10. The flour should be light in color--very pale yellow for cottonseed; almost white for peanuts.

11. The flour should be free of solvent.

12. The flour should be relatively free of deleterious solvent contaminants, decomposition products, etc.

13. The flour should be prepared under sanitary conditions that meet standards set by food processors and by government.

14. Oil quality and yield should be maintained.

(A slide of sections of glanded and glandless cottonseed was shown).

Mr. Harper will report on the status of processing of glandless cottonseed. You can see the glandless kernels are free of pigment glands. Note the presence of the small dots in the glanded cottonseed. They are called pigment glands. They contain 40 to 50 percent gossypol. They represent about 2 percent of the weight of the kernel.

As you know these pigment glands, that is the gossypol pigments present within the glands, are responsible for your oil color problems. Depending upon processing conditions, the pigment glands can adversely affect the quality of your meal product.

It takes a great deal of mechanical energy to rupture these glands. It is readily evident that conventional rolling, as practiced by the cottonseed industry, does not compress the cracked meats sufficiently to break or rupture these glands. This is illustrated in table 2.

The presence of water in the preparation, conditioning, and cooking renders the glands much more susceptible to rupture.

The point I want to get across is that in conventional processing, such as prepress solvent extraction (using commercial hexane), the preparation operations involved, together with the poor solvent power of the hexane for gossypol, only partly removes the gossypol from the meal. Much of it remains in the final meal in a bound form, which is also responsible for appreciably lowering the lysine value and thus adversely affecting the nutritional value of the meal

Let us look at a cottonseed meal (sample shown), a 50 percent protein product prepared from glanded cottonseed by prepressed solvent extraction. It is a typical one. It has a free gossypol content of 0. 03, but a total of about 1 percent. It has an EAF lysine value well below 3. 5 g. /16 g. nitrogen.

Table 2.--Screen analysis of cottonseed pigment glands[1]

Mesh	Inch openings	Micron sizes	Weight of fraction	Retained	Through
			G.	Pct.	Pct.
40	0.0165	420	0.005	0.0	100.0
60	.0098	250	.033	.1	99.9
80	.0070	177	.040	.2	99.7
100	.0059	149	1.010	4.0	95.7
120	.0049	125	3.445	13.7	82.0
140	.0041	105	7.800	30.9	51.1
170	.0035	88	6.266	24.9	26.2
200	.0029	74	4.075	16.2	10.0
230	.0024	62	1.345	5.3	4.7
270	.0021	53	.572	2.3	2.4
-270	-.0021	-53	.612	2.4	---

[1] Table taken from "Pilot-Plant Fractionation of Cottonseed. I. Disintegration of Cottonseed Meats," by J.J. Spadaro, R.M. Persell, C.H. Murphey, Jr., H.L.E. Vix, E.J. McCourtney, J.L. Hecker, E.F. Pollard, and E.A. Gastrock. J.Am. Oil. Chemists' Soc. 25(10): 345-353. 1948. (Presented at 39th Ann. Meeting, Am. Oil Chemists' Soc., New Orleans, La., May 4-6, 1948.)

Now let us look at a flour (sample shown) prepared at SURDD from glandless cottonseed--prepared by solvent extraction with commercial hexane of hull-free flaked meats.

Note the extreme difference in color between these two products. The glandless cottonseed flour product is bland in flavor. It has less than 0.01 percent free and total gossypol. The EAF lysine of this product is 3.9+ g./16 g. N. This is a high grade food product, one that could find many uses in food formulations.

One will readily ask, what are the prospects of producing cottonseed flours for food uses from glanded cottonseed that approximate the quality of flour prepared from glandless cottonseed? No doubt we will be processing glanded cottonseed in this country for some time, and perhaps longer in foreign countries.

At SURDD we have been giving this matter much attention. Our efforts have been directed along several lines of research. The first two I will mention briefly.

1. Fractionation and air classification--through such means it may be possible to prepare a fraction of cottonseed flour which approximates in color and quality that of glandless cottonseed flour.

2. Another line of research just getting under way is a mechanical approach involving cold screw pressing extrusion operations. No results are available to report.

Now I come to research at SURDD that I want to feature.

For some time we have been investigating solvent systems, other than commercial hexane alone. These are polar solvent systems--they readily rupture pigment glands--and extract or remove gossypol readily. These solvents have been used in our pilot-plant systems. These systems involve conventional type extractors, such as the basket extractor, and some departures, such as vibrating screens, centrifuges, and liquid cyclones for handling finely comminuted cottonseed meats. In such material both the oil and gossypol are extracted more completely and rapidly. Mr. Gastrock, Dr. Frampton, and their associates are responsible for the progress made to date. They can supply you with more details concerning the processes developed.

Several solvents and solvent combinations have received study. These are acetone, acetone-water mixtures, acetone-water-hexane mixtures, ethyl alcohol, isopropyl alcohol, methyl ethyl ketone, and ethyl acetate.

The most promising systems involve acetone. Ethyl acetate might prove to be another good solvent.

I have before me two cottonseed flours--one prepared by the AHW (acetone-hexane-water) process and the other, a cottonseed flour prepared by a two-stage extraction, the first stage aqueous acetone (25 percent water by weight), second stage anhydrous acetone is used as a solvent.

These two flours are of high quality and should find wide acceptance in food uses.

The AHW flour is prepared from prime glanded cottonseed in conventional basket extraction pilot plant using a mixture of 39 percent acetone, 60 percent hexane, and 1 percent water. The resulting oil miscella from such processing contains all gossypol pigment extracted from the prepared meats. Miscella refining can be employed to obtain a prime oil. Extensive feeding tests with this AHW meal to swine, poultry, and of the flour to infants after weaning gave excellent results.

The AHW meal product has proved to be better in nutritional quality than commercial cottonseed meals and practically comparable in quality to high grade soybean meal. The AHW process can be given primary consideration in India, South America, and other developing areas as a means for producing quality edible flours from cottonseed.

The flour from the other process, the two-stage extraction process, that is, aqueous acetone followed by anhydrous acetone is from a process under development at SURDD.

In the first stage the 25 percent water, 75 percent acetone solvent system extracts practically all the gossypol, free-fatty acid (FFA), some raffinose, very little oil, and effectively removes aflatoxin from the meal (if present).

The extract from the first stage is about 5-7 percent by weight of the meats.

The second stage yields a light-colored crude oil and a light-colored meal or flour.

For both the AHW process and the two-stage aqueous acetone-anhydrous acetone process, it is possible to bring the total gossypol content down to 0.05 percent or less by incorporating a solvent milling or grinding operation prior to extraction. Thus, by combined mechanical-solvent effects, the pigment glands are more completely disintegrated and gossypol is more completely extracted. By using flakes 0.007 in. in thickness and not solvent milling, the total gossypol in the final meal or flour product can be reduced as low as 0.15 percent.

The nitrogen solubility of the flours from both processes is about 85 percent or higher, and the lysine, EAF approaches 4.0 g./16 g. of nitrogen.

The protein content is about 58 to 59 percent.

Flours are prepared by grinding the desolventized marc through a Kolloplex Mill (a sieveless stud type mill).

We believe that for both processes, necessary sanitary requirements can be readily met since little conditioning or preparation of meats to flakes is required for extraction, and further that the extraction desolventizing and grinding operations will afford means of avoiding any contamination.

We believe that the flavor problem associated with the use of acetone can be adequately solved by purchasing acetone under specifications, by proper storage, by selection of extraction and desolventization conditions, and through rectification of the recovered acetone before reuse. These steps are necessary to either prevent formation or remove any off-flavor acetone byproducts such as diacetone alcohol and mesityl oxide. Dr. Dupuy and Mr. Gastrock are responsible for the progress made in making possible necessary information to use acetone under conditions which does not adversely affect the flavor of the final flour.

From the standpoint of cost, one will readily realize that the cost to produce such flours by these two processes will be somewhat higher than for a comparable soybean flour, but we feel that we are in the ball park, from the standpoint of food product costs, particularly for some specific developing countries.

I have used these two processes and their corresponding meal products to illustrate that through technology and engineering it is possible to upgrade cottonseed flour to the stage where it should find wider uses in foods particularly in developing countries.

It is possible that such processes may find use in this country to produce higher quality cottonseed meal for feed uses.

If we believe that we should aid the developing countries to feed themselves, then we must act with vigilance, vigor, and direction to move cottonseed as an oilseed protein source in world food channels, along with protein sources from other oilseeds, from fish meal and from petroleum. We must be aware that we are not accustomed to using cottonseed meal or flour as a food for our own use. This may make our job a little harder. People in other countries often say if a food is good enough for the United States people, it is good for us.

The time is coming for us to set up demonstration pilot plants using the best process, perhaps one under development at SURDD, to produce the best cottonseed flour of highest quality.

Perhaps, it is best to set up such a plant first in the United States. Here, the product will be immediately available for wide and complete evaluation by American food processors, and also for foreign food industries for evaluation and promotion of the process and product.

In the next 33 years, before the year 2000, this world will produce between 3/4 and 1 billion tons of cottonseed. Whether a great quantity of this available protein source will find its way to the millions of hungry people in the world depends upon the steps we and the developing countries take today. This is a rapidly changing world--Progress means changes.

INACTIVATION AND REMOVAL OF AFLATOXIN--PROGRESS REPORT

by

Frank G. Dollear

Southern Utilization Research and Development Division

Considerable progress has been made during the past year on inactivation and removal of aflatoxin from contaminated oilseed meals. We have found several promising approaches for inactivation by chemical treatment and have prepared sufficient quantities for biological evaluations which have been carried out at the Western Utilization Research and Development Division. We have learned more about the conditions required for removal of aflatoxins from oilseed meals by extraction with aqueous acetone. This extracted meal has also been evaluated by using duckling and rat feeding tests. With regard to aflatoxin, inactivation and removal results of these tests are encouraging. There has, however, been some sacrifice in nutritional quality during this processing.

Cooking aflatoxin contaminated peanut or cottonseed meals with added moisture at temperatures up to 212° F., for periods up to 2-1/2 hours, reduces the aflatoxin content, but does not achieve the levels desired, i. e., less than 30 parts per billion of total aflatoxins. Table 1 shows the effect of cooking at different moisture contents on the aflatoxins of a cottonseed meal selected for its high aflatoxin content. The original meal had an aflatoxin B_1 content of 140 parts per billion (p. p. b.) and an aflatoxin B_2 content of 70 p. p. b., or a total aflatoxin content of 210 p. p. b.

None of these heat and moisture conditions reduced the total aflatoxin below 30 p. p. b. but higher moisture content favored aflatoxin reduction. Temperatures below 212° F. were less effective as were moisture contents below 15 percent. At moisture contents above 22 percent, difficulties were experienced with stirring due to plasticization of the meal particles. This research on the effect of heat and moisture on aflatoxin content served as a guide and control for experiments on inactivation with added chemicals. A manuscript has been prepared for publication which will give more details of experiments on the effect of heat and moisture on aflatoxin content.

For biological testing of treated meals, we chose as a goal reduction of total aflatoxin content to 20 p. p. b. or less. This was achieved on a peanut meal selected for high aflatoxin content with four different chemical inactivation treatments and 15 kg. batches of each treated meal were prepared.

Table 1. --Heat treatments of cottonseed meal at 212° F.

Moisture	Time	Aflatoxins in heated products, p. p. b.		
		B_1	B_2	Total
Pct.	Min.	P. p. b.	P. p. b.	P. p. b.
15	30	108	36	144
	60	81	36	117
	90	54	22	76
	120	65	29	94
	150	29	14	43
20	30	81	27	108
	60	65	27	92
	90	54	27	81
	120	33	11	44
	150	33	11	44
30	60	54	Trace	54+
	150	31	Trace	31+

Treatment of meals with sodium hydroxide and methyl amine was carried out at atmospheric pressure in a steam jacketed, stainless steel Groen reaction kettle. This equipment proved too large for efficient ozone treatment because of the limited capacity of our laboratory ozone generator. Hence, to produce meal for biological evaluation several runs were made in the 1 gal.-bench scale reactor and batches of ozone treated meals were pooled.

An ammonia treated meal was prepared in the pilot plant in a pressure reactor.

The same peanut meal was subjected to each of the inactivation treatments and to acetone extraction for biological evaluation. This meal contained 70 p. p. b. of aflatoxin B_1, 30 p. p. b. of aflatoxin B_2, and 11 p. p. b. of aflatoxin G_1--or a total of 111 p. p. b. Reaction conditions for sodium hydroxide and methyl amine treatments of this peanut meal and the aflatoxin contents of the treated meals are shown in table 2. When this same meal was cooked for 2 hr. at 212° F. with 30 percent moisture, but without addition of chemicals, the resulting aflatoxin contents were 26 p. p. b. B_1, 17 p. p. b. B_2, and 4 p. p. b. G_1--or a total of 47 p. p. b. of aflatoxins.

The reaction conditions for ozone treatment and aflatoxin contents of treated meal are shown in table 3. It has been observed that ozone is more effective in inactivation of aflatoxin B_1 than the more saturated aflatoxin B_2.

Table 2. --Sodium hydroxide and methyl amine treatments of peanut meal

Item		Sodium hydroxide	Methyl amine
Cooking:			
Temperature	°F.	212	212
Time	hr.	1.5	1.5
Weight of meal	lb.	15	15
Reagent used	pct.	2	1.25
Moisture content	pct.	30	30
Drying:			
Time	hr.	1	1
Temperature	°F.	130-140	130-140
Aflatoxin content:			
B_1	p. p. b.	9	0
B_2	p. p. b.	6	Trace
G_1	p. p. b.	2	Trace
Total	p. p. b.	17	Trace

Conditions for treatment of the peanut meal with anhydrous ammonia in a pressure reactor are shown in table 4. The ammonia treatment effectively reduced the aflatoxin content and increased the nitrogen content of the meal, 0.46 percent.

Extraction of the peanut meal with aqueous acetone, 10 percent water and 90 percent acetone on a weight basis, was carried out as a batch process in a single basket of our pilot-plant basket extractor. The basket is 8 x 8 x 23 in. deep, has a tapered bottom, and a

Table 3. --Ozone treatment of peanut meal

Item		Ozone
Cooking:		
Temperature	° F.	212
Time	hr.	2
Weight of meal	lb.	1. 5
Reagent used	mg. /min.	25
Moisture content	pct.	30
Drying:		
Time	hr.	1
Temperature	° F.	130-140
Aflatoxin content		
B_1	p. p. b.	5
B_2	p. p. b.	10
G_1	p. p. b.	3
Total	p. p. b.	18

Table 4. --Ammonia treatment of peanut meal

Item		Ammonia
Reaction conditions:		
Temperature	° F.	163
Pressure	p. s. i. g.	43
Time	hr.	0. 25
Weight of meal	lb.	15
Ammonia concentration	pct.	6. 7
Moisture content	pct.	15. 0
Aflatoxin content:		
B_1	p. p. b.	Trace
B_2	p. p. b.	Trace
G_1	p. p. b.	Trace
Total	p. p. b.	Trace

Table 5. --Acetone extraction of peanut meal

Item		Conditions
Extraction conditions:		
Temperature	° F.	118-120
Weight of meal	lb.	15
Initial charge of hot aqueous acetone (1:9)	lb.	22. 5
Soaking time	min.	30
No. of washes		4
Time, each wash	min.	10
Solvent used, each wash	lb.	22. 5
Total solvent to meal ratio		7. 5 to 1
Moisture content of marc	pct.	11. 2
Aflatoxin content:		
B_1	p. p. b.	0
B_2	p. p. b.	0
G_1	p. p. b.	0
Total	p. p. b.	0

screen and gate valve. It was insulated with rock wool to reduce heat loss. The conditions for extraction are given in table 5. The 90 percent acetone was preheated to about 122° F. before pumping to the extractor. Fifteen pounds of peanut meal and 22. 5 lb. of acetone were added to the basket simultaneously, and a soaking period of 30 min. allowed. After drainage, four washes were carried out with fresh solvent. The marc was air dried. As noted in the table, aflatoxins were not detected in the extracted meal by the thin layer chromatographic procedure.

For efficient extraction of aflatoxins with 90 percent acetone, maintenance of the temperature at about 118° F. or higher has been found desirable. Since acetone has a boiling point of 132° F., this limits extraction temperatures which may be achieved at atmospheric pressure.

As a control for the biological evaluations, a high quality peanut meal was used. This had been prepared in the pilot plant from shelled U. S. No. 1 grade peanuts. These were rolled, cooked for 35 to 40 min. to a maximum temperature of 220° F., then hydraulic pressed. The composition of the meals submitted for biological evaluation is shown in table 6.

The nitrogen solubility and the available lysine content were reduced by some of the treatments. Acetone extraction produced only a small reduction in nitrogen solubility and no change in available lysine.

The chemically treated, acetone-extracted, and aflatoxin-contaminated peanut meals were each fed to 10 ducklings as 60 percent of the diet for 2 weeks by M. S. Masri of our Western Utilization Research and Development Division. The high quality peanut meal was fed at a 65 percent level as a control. Weights were determined after 1 or 2 weeks, and the livers removed for histopathological examination. The mean duckling weights are shown in table 7. The best weight gains were observed with the 90

Table 6.--Composition of peanut meals

Item		Controls		Inactivation treatment				Extraction
		High-quality meal	Original meal	Sodium hydroxide	Methyl amine	Ozone	Ammonia	90 percent azetone
Moisture	pct.	6.41	7.22	6.86	8.86	6.30	7.90	9.74
Oil (MFB)	pct.	8.6	0.75	0.49	0.26	0.28	0.63	0.16
Nitrogen (MFB)	pct.	9.17	9.82	9.67	10.75	9.96	10.39	10.14
Crude fiber (MFB)	pct.	4.1	5.0	4.9	4.9	4.3	4.8	5.0
Ash (MFB)	pct.	4.65	5.34	6.86	5.41	5.23	5.43	5.67
Nitrogen sol.	pct.	93.3	82.4	55.9	60.5	59.2	70.0	79.6
Avail. Lysine g./16	g.N	3.2	2.8	2.4	2.4	2.5	2.7	2.8

Table 7.--Mean duckling weights at 1 and 2 weeks on treated and untreated peanut meals

Meal	In diet	Mean body weight	
		1 week	2 weeks
	Pct.	G.	G.
High quality peanut	65	168	514
Aflatoxin contaminated	60	163	501
Sodium hydroxide treated	60	158	454
Methyl amine treated	60	156	447
Ozone treated	60	139	410
Ammonia treated	60	155	453
90 percent acetone extracted	60	174	536

percent acetone extracted peanut meal, whereas other treated meals gave lower weight gains than the high quality peanut meal and the aflatoxin contaminated peanut meal.

Microscopic examination of each of the livers from these ducklings was carried out by Wilfred E. Gagne of the Pharmacology Laboratory, WURDD. He has reported that histopathological results associated with aflatoxicosis were present in 4 of 10 livers from ducklings fed the original aflatoxin contaminated peanut meal. The lesions were well defined but not extensive or severe. They could be considered 1+. Neither the treated peanut meals nor the 90 percent acetone extracted peanut meal produced any observable liver damage.

Although the biological data are limited, I think we can conclude that the treatments reported here have substantially reduced, inactivated, or eliminated the aflatoxins from the contaminated peanut meal based on thin layer chromatographic assay and biological tests. There appears to be a reduction in protein quality during some of the treatments. This has been confirmed in rat feeding tests carried out by A. N. Booth of WURDD. Protein efficiency ratios (PER) and protein retention efficiencies (PRE) are summarized in table 8. The PER's reported are average values corrected to compare with casein as a control at 2.50. Each meal was fed at a level of 10 percent protein to five weanling female rats. The PRE values are calculated net protein utilization (NPU) values, based on feeding tests but without analysis of the rat carcass for its nitrogen content.

In the January 1966 issue of Cereal Science Today, Daniel Banes, Deputy Director, Bureau of Scientific Research, Food and Drug Administration, Washington, D. C., set forth a guideline for aflatoxin inactivation or elimination which I should like to quote:

> "Several investigators have attempted to rehabilitate infected feeds by treating them with various solvents or oxidizing agents. We cannot approve these

Table 8. --Summary of rat protein efficiency ratio (PER) and protein retention efficiency (PRE) assays on peanut meals

Test diet	PER corrected	PRE
Casein control	2. 50	68. 96
High quality peanut	1. 91	52. 48
Aflatoxin contaminated	1. 82	52. 48
Sodium Hydroxide treated	1. 36	47. 36
Methyl Amine treated	1. 31	45. 28
Ozone treated	1. 16	42. 88
Ammonia treated	1. 49	46. 72
90 percent Acetone extracted	1. 62	49. 92

> practices until evidence is forthcoming that the nutritive value of the feed is unimpaired and all toxins are destroyed."

I believe some of the processes described today are approaching this guideline. Further research is needed to develop these processes further for practical application. We need to see if we can inactivate the aflatoxins with better retention of nutritive quality. We are also planning some experiments to see if inactivation treatment and 90 percent acetone extraction can be put on a continuous basis.

There are other aflatoxins that haven't been discussed up to this point. Aflatoxin G_2 was not observed in the meals subjected to treatment. Neither were the "milk toxins," M_1 and M_2. The latter are hydroxyl derivatives of B_1 and B_2 where a hydrogen in the 4-position of the terminal furane ring has been replaced by hydroxyl. Two new hydroxy aflatoxins have recently been reported as metabolites of Aspergillus flavus by Dutton and Heathcote. These have been named aflatoxins B_{2a} and G_{2a} and are hydroxy derivatives of B_2 and G_2 with the hydroxyl groups substituted at the 2-position of the terminal dihydrofurane ring. Although we do not yet have standards of these for comparison, we will be observing the TLC plates from our treated meals to assure that there are no spots at the reported R_f values.

I am sure you recognize that this research has been a team effort and I have already referred to the cooperation of investigators at the Western Utilization Research and Development Division. Here at the Southern Utilization Research and Development Division the work reported has been carried out by Godfrey E. Mann, Eric T. Rayner, and Louis P. Codifer of the Oilseed Crops Laboratory; C. T. Dwarakanath, of Mysore, India, a UNICEF Fellow assigned to this Laboratory; and by Homer K. Gardner and Stanley P. Koltun of the Engineering and Development Laboratory. We have had the guidance and encouragement of L. A. Goldblatt, Chief, Oilseed Crops Laboratory, and H. L. E. Vix, Chief, Engineering and Development Laboratory. The biological evaluation was arranged through A. C. Keyl, Chief, Pharmacology Laboratory, WURDD, who is to be your next speaker.

AFLATOXIN TOXICITY IN FARM ANIMALS

by

Alexander C. Keyl

Western Utilization Research and Development Division

The criteria of toxicity to be used in the following preliminary report on aflatoxin toxicity in selected farm animals represent statistically significant departures from normal values for a number of physiological parameters as a function of dosage of dietary aflatoxins for fixed periods of time. Extrapolation of these findings to other species of animals on other dietary aflatoxin regimens is unwarranted and misleading. The experimental design was based on American animal husbandry practices and represented a practical as opposed to a theoretical approach in an attempt to answer certain questions raised at joint industry--Food and Drug Administration (FDA), U. S. Department of Health, Education, and Welfare--U. S. Department of Agriculture mycotoxin research panel meetings over the past 2 years.

Swine Feeding Trials

The swine feeding trial with aflatoxin-contaminated peanut meals was divided into two parts involving dietary levels of aflatoxin B_1, ranging from 0 (soybean control) 2, 7, 51, 105, and 233 p. p. b. in the first trial, and 0, 6, 465, 600, and 810 p. p. b. in the second trial. The experimental groups at each level consisted of five gilts and five barrows (Duroc-Jersey) starting at approximately 50-lb. weight and finishing at 200-lb. weight at slaughter. The feeding period varied from 110 to 120 days. The diet consisted of a ration comprising 75 percent whole ground barley, 15 percent peanut meal, 5 percent alfalfa meal, 4 percent meat and bone-meal, 0. 5 percent salt, and 0. 5 percent vitamin premix.

Up to and including dietary levels of 233 p. p. b. aflatoxin B_1, all results were negative in the sense that no significant differences were noted between control and treated groups with respect to mean weight gains, total feed intake, and feed efficiency values. Blood samples taken four times during this period for hematological and biochemical evaluation revealed no significant differences for hemoglobin, hematocrit, red cell count, white cell count, and differential leukocyte counts. No differences were found with respect to plasma transaminase, N. P. N., Urea N, copper and Vitamin A. The only parameter showing a significant increase at the 5 percent probability level was serum alkaline phosphatase. Electrophoretic separation of the albumin and globulin fractions of these samples revealed no significant difference in the gamma globulin fraction.

At autopsy, no significant differences were found with respect to organ weights (kidneys, liver, spleen, adrenals and thyroid). Histopathological examination of some 20 tissues showed no pathological abnormalities related to aflatoxin intake.

In the second part of the trial involving relatively high dietary levels of aflatoxin intake (465, 600, and 810 p. p. b.) significant differences were observed at one or more levels between control and treated groups with respect to weight gains, feed efficiency, serum glutamic-oxalacetic transaminase, serum alkaline phosphatase, isocitric dehydrogenase, N. P. N. organ weights (liver and kidneys), and histopathological changes in the liver (degenerative changes in liver cells, enlarged nuclei, and bile duct hyperplasia).

Residue analysis. --Blood and tissues (lean meat, fat, spleen, liver, and kidney) were collected at slaughter, lyophilized, and then subjected to chemical and biological assays.

All tissues, including blood, showed no chemical or biological evidence of aflatoxin residue detectable by current assay methods, i. e., Food and Drug Administration (FDA) chemical method (Nesheim and Campbell) and FDA duckling, and 2 and 6 weeks feeding of ducklings, (with liver histopathology and growth curves as the criteria of toxicity). However, the blood of the swine at various levels, except the soybean controls and the peanut meal control of the first trial, showed varying amounts of an aflatoxin-like substance which is very difficult to distinguish from aflatoxin B_1.

A comparison of the untraviolet absorption spectra of aflatoxin B_1 and the "blood factor" permits easy differentiation between the two compounds. If special "defatting" procedures are used, the two compounds may be distinguished from each other by thin-layer chromatography techniques.

Beef Cattle Feeding Trials

Fifty crossbred beef steers purchased on the open market at age 6 to 8 mo. and in a body weight range of 400 to 500 lb. were used. The feeding trial was started on December 14, 1965. The composition of the basal ration was as follows (in percent): Alfalfa hay 14, oat hay 6, beet pulp 8, milo corn 20, barley 24, cottonseed meal 15, fat 2, molasses 10, salt 1. Vitamin A and oyster shell were also added. Approximately 20 tons of prime quality cottonseed meal produced in California, containing not less than 41 percent and not more than 0. 04 percent gossypol, was purchased at the University of California, Davis, for this feeding experiment. Three tons of this meal was shipped to Southern Utilization Research and Development Division to be fortified with mold (containing aflatoxin) grown on rice at Northern Utilization Research and Development Division. The aflatoxin B_1 content of the fortified meal was 11,000 p. p. b. By proper blending of the fortified and unfortified meal, the following levels of aflatoxin in the ration were fed.

Group	Aflatoxin in ration P. p. b.
1 (control	0
2	100
3	300
4	700
5	1000

10 steers in each group

Mean weight gain and feed efficiencies at the end of 133 days are summarized in table 1.

Both weight gains and feed efficiencies appear to have been adversely effected, especially when the level of aflatoxin in the ration was increased to 700 and 1,000 p. p. b.

Weekly hematology evaluations were made during the course of the feeding trial. No effects related to aflatoxin intake could be detected from the hematocrit, hemoglobin, red blood cell, and white cell values. Likewise, the blood cholesterol values were unaffected by the ingestion of aflatoxin.

At autopsy, liver, spleen, heart, kidney, and adrenal weights were recorded in table 2.) The organ weights per 100-lb. body weight all appear to be within the range of the control group values with the exception of liver weights which increased when the level of aflatoxin in the ration was 700 p. p. b. or higher. The liver from three of eight steers fed 1,000 p. p. b. and two of 10 steers fed 700 p. p. b. were grossly abnormal by being grayish in color, enlarged, and having a fibrous (rubbery) texture. Below 700 p. p. b., no gross liver abnormalities were observed.

From these results (excluding the microscopic and blood enzyme studies), it was tentatively concluded that no abnormal effects were produced when the aflatoxin level in the rations was 300 p. p. b. or lower. Evidence of liver damage was observed when the aflatoxin level was 700 p. p. b. or higher.

The serum enzymes, alkaline phosphatase, and malic dehydrogenase increased in activity in response to aflatoxin, while lactic dehydrogenase decreased. Blood urea nitrogen, serum albumin, and total serum protein all decreased. Glutamic-oxalacetic transaminase, isocitric dehydrogenase, and E_{260} values were not affected. A possible significant no-effect level of dietary aflatoxin may be estimated from these blood factors as lying between 300 and 700 p. p. b.

Liver glutamic-oxalacetic transaminase, malic, and isocitric dehydrogenases all became depressed in response to aflatoxin. No effect levels were generally estimated to be between 100 to 300 p. p. b. Lipid and vitamin

Table 1. --Beef cattle cottonseed meal (aflatoxin) feeding trial

Ration		Mean body weights Initial	 After 133 days	Daily gain	Feed efficiency (gain/feed)
		Lb.	Lb.	Lb.	
Control		401	734	2.50	0.152
100	p. p. b.	427	777	2.63	.143
300	p. p. b.	417	738	2.41	.139
700	p. p. b.	406	659	1.90	.134[2]
1,000	p. p. b.	433	679[1]	1.85	.136[2]

[1] One steer died on 59th day of experiment

[2] Eight steers were confined in metabolism cages for 1 week.

Table 2. --Effect of Aflatoxin ingestion on organ weights of beef cattle

Aflatoxin level		Mean organ weights (g./100 lb. body weight) Liver	 Spleen	 Heart	 Kidneys (2)	 Adrenals (2)
Control		604	98	193	90	1.5
100	p. p. b.	662	103	194	98	1.9
300	p. p. b.	622	83	189	96	1.8
700	p. p. b.	937	92	208	106	2.1
1,000	p. p. b.	706	89	193	106	1.6

A also decreased, however, with a no-effect level here of 700 to 1,000 p.p.b. Alkaline phosphatase, lactic dehydrogenase, glycogen, and E_{260} values were unaffected.

It should be noted that this no-effect level is set by the minimum detectable difference of a given assay, even though the observed changes may be significantly proportional to aflatoxin concentration and imply a more continuous effect over the entire aflatoxin range.

Progress Report--Aflatoxicosis of Cattle

(A) Livers from nine steers of the 1,000 p.p.b. group have been examined microscopically. Proliferation of bile ducts, accompanied by severe peribiliary fibrosis on occasion, was the most commonly recognized lesion. Severe centralobular hemorrhage was present in one animal and one liver was negative. Cellular changes were present but minimal.

Tissues from control animals, the 100 p.p.b. group, and the 1,000 p.p.b. have been fixed, dehydrated, embedded and placed on slides and are now ready for microscopic examination.

(B) Dried blood from the 1,000 p.p.b. group were fed at 20 percent of the diet to ducklings for a period of 6 weeks with no adverse effect on weight gain or any adverse liver histopathology. Chemical examination of the blood samples were negative with respect to aflatoxin B_1.

(C) The recent publication by Holzapfel and coworkers on the isolation and structure of aflatoxins M_1 and M_2 in which it appears that (1) the de Iongh "milk factor," (2) the chief urinary metabolite of aflatoxin B_1 in the sheep, and (3) a certain metabolite of A. flavus are identical is confirmed by our studies on the milk and urinary aflatoxin B_1 metabolites in sheep and dairy cattle.

This concludes the highlights of the large animal feeding trials progress report as of this date. Further studies involving transmission of aflatoxin into poultry and eggs are contemplated.

THE FUTURE OF COTTON

by

Senator Allen J. Ellender

I am pleased to talk with you today about a subject of immense interest, not only to this group, but to the South as a whole.

Cotton has always had its problems, but in recent years these problems seem to have intensified and to have become more complex. In spite of the fact that a great deal of attention has been centered upon improving the competitive position of cotton at the national level, as well as at regional and local levels, there is ample evidence to indicate that its importance is steadily declining.

Here in Louisiana, for example, cotton has been the number one crop for as long as I can remember, with sugarcane and rice not too far behind. In the last few years, however, significant changes have taken place. In 1963, the Louisiana cotton crop was valued at about $111 million and cottonseed at $14.5 million. In 1966, lint-cotton was valued at only $49 million, less than one-half the value of the crop in 1963, and the value of cottonseed amounted to $21 million.

On the other hand, the value of the rice crop in 1966 had reached $102 million, and sugarcane was valued at $65 million. Soybean production, which had a value of about $16 million in 1963, was valued at $63 million in 1966. In other words, cotton has lost its number one position.

While it may be true that cotton is no longer King, the fact remains that this crop is still of tremendous economic significance in Louisiana, as well as in other areas of the South. Therefore, it behooves all of us to work toward the development of an environment for cotton which will not only arrest its decline but contribute to its expansion. I know this is my intention.

Of course, we all know the reason for the sharp drop in the value of the cotton crop last year was simply a matter of less cotton at a sharply lower price. This can be traced directly to the new cotton laws which were enacted in 1964 and 1965. I am proud that the record will show clearly that I opposed those laws.

I will concede that some action was necessary in 1964. You will recall that carryover stocks of Upland cotton at that time amounted to 12.1 million bales, with further increases expected. Allegedly, domestic mill consumption of man-made fibers was increasing at the expense of cotton because of a wide price differential. Finally, our export market was being lost because our foreign competitors were underselling us.

The 1964 Act was supposed to correct these problems. However, it became quickly apparent that the situation was only further aggravated. The outlook in 1965 was quite gloomy and it was felt that new legislation was necessary. The carryover had increased again and it was expected that at the beginning of this marketing year it would amount to over 16 million bales. Actually, the carryover on August 1, 1966, amounted to 16.6 million bales. I had hoped for a more moderate program than that proposed by some segments of the industry and backed by the Administration.

The record will show that in opposing this law I pointed out that the cost of the program would increase; that domestic textile mills, although the only beneficiaries, would increase consumption of cotton only slightly; that use of manmade fibers would continue to increase; that our export market would react no differently than before; and that there would be severe economic dislocations within the cotton agribusiness industries.

Forgive me for bragging but I think I have been proved correct on all counts.

First, the cash outlay for the program has increased. Payments during the 1964 and 1965 years averaged about $441 million each year. In 1966, they amounted to $772 million.

Second, domestic mill consumption of cotton did increase, but only slightly. In 1964, the first year of low price cotton, mill consumption increased by about 500,000 bales. In 1965, there was another increase of about 350,000 and in 1966-67, consumption is expected to be only 1 million bales more than that used in 1963.

For the past several years, this country has been engaged in a war in Vietnam, in addition to our other commitments around the world. This additional drag upon our resources, as we all know, has created some inflationary pressures. Our domestic economy until recent months has also been operating at a maximum rate. Domestic cotton mills have shared in the increased demand which was created by the Vietnam situation, as well as by our internal economic expansion. Yet, in spite of this tremendous spurt in economic activity, they are now using only 1 million bales more than before the 1964 Act took effect.

When I charge that the domestic textile mills are the principal beneficiaries of the new cotton law, I base it only on the facts.

All of you here are familiar with the term "mill-margins." Although it may have varying connotations, I think generally we know that it means the gross difference between the price paid for the raw commodity and the price charged for the finished product. I know it is not a measure of profits, but the direction of a change can indicate whether an industry is in a better or worse condition than before.

In January 1964, before the so-called one-price cotton law took effect, domestic textile mills were paying an average of 35.47 cents per pound for cotton used in the 20 constructions as reported by the Department of Agriculture.

Data from these same reports were used by the textile mills, as a basis for a scientific study to show how badly they were doing, and were included in the hearings on the 1964 cotton law held by the Committee of which I am Chairman. In December of 1966, mills were paying 10 cents per pound less for cotton than when the one-price law became effective. In addition, strong demand caused cloth prices to increase over 2-1/2 cents a pound above the earlier period. As a result, mill margins, which is the difference between cloth and cotton prices, showed an average increase of 12.67 cents.

Even with lower prices, the new cotton law has not halted the increased use of manmade fibers by textile mills. The latest information shows that cotton's share of total fiber consumption is now slightly less than 50 percent, an all-time low. In 1963, cotton's share amounted to 55.7 percent. On the other hand, the manmade fiber share increased from 38.4 percent in 1963 to 45.6 percent in 1966. Wool's share of the market also decreased slightly from 5.7 percent to 4.3 percent.

Now for our exports. I have long said that a strong export market is vital if we are to develop an expanding domestic cotton economy. This year our exports are expected to total about 5 million bales. This is about 3 million more than last year but less than 1 million more than the previous 5-year average. It is imperative that our export market be increased.

Heretofore, we have penalized ourselves by announcing an export price at the beginning of the year and maintaining this price throughout the year. As a result, our competitors in world markets have been able to undersell our crop and we have become residual suppliers. Given the proper tools and environment, our export merchants could once again achieve the number one position for this country in world markets which we lost a good many years ago. Our exporters know cotton and they know how to sell it. But, we cannot expect them to do a job when we tie their hands with an unrealistic price policy.

One aspect of the new cotton law that was largely overlooked was the sharp cut in production such as occurred last year. I had warned, of course, that too sharp a cut would have chaotic effects on the economies of local areas and on the agribusinesses which depend upon cotton for their well being.

I do not have to remind you that production in 1966 was substantially below that of 1965. Only 9.5 million bales of cotton were produced with a cottonseed yield of about 4 million tons. This was 5.2 million bales below the 1965 production. As a result, cottonseed production was about 2.1 million tons below that produced in 1965.

I realize that the cottonseed oil mill industry, as well as other segments of the cotton economy, is having a very difficult time this year. In January 1967, farmers were receiving $65.30 per ton for cottonseed, as compared to only $47.80 last year. While this is extremely desirable from the standpoint of farmers, it certainly is having an adverse effect on your industry.

Since cottonseed is a byproduct of cotton, your livelihood is dependent upon a strong, viable cotton economy. Furthermore, your competitive position in the oil industry is largely determined by forces over which you have little or no control. Soybean production, as well as the production of other oil-bearing crops, also directly affects your well-being. In short, you have a real and direct interest in a high level of cotton production.

Therefore, let us review what has happened and try to predict what will happen in the near future. As you know, the law enacted in 1965, covered the cotton crops through 1969. That law does provide the Secretary of Agriculture with considerable flexibility in developing a program tailored to meet our needs, reduce our surpluses, and encourage maximum utilization of cotton, both in domestic markets and for export.

In 1966, and again this year, the program was designed to encourage maximum participation by farmers. You will recall that planted acreage last year was about 25 percent less than in 1965, and about one-third less than the 1960-64 average.

Although no official information is available at this early date, there is no reason now to believe that planted acreage will be significantly different in 1967.

However, there is reason to hope that production in 1967, will be significantly larger than the 9.5 million bales of Upland cotton produced last year.

As a matter of fact, as late as September 1966, the Department of Agriculture was predicting an Upland cotton crop of about 10.9 million running bales and cottonseed production of 4.5 million tons. However, subsequent bad weather across the belt from California to North Carolina caused yield estimates to drop from 530 pounds to 482 lb. per acre and production to be reduced by about 1.4 million bales. Cottonseed production was reduced by about 500,000 tons. Therefore, if moderate weather prevails this year, I think that we can expect some increase in production in 1967 over last year. I realize that the increase will not be enough to satisfy your industry, but in the long run I think that you will see that these reduced plantings now are necessary.

Now, let us look at the other side of the coin. Latest estimates indicate that the disappearance of cotton during this marketing year will total about 14.5 million bales with domestic consumption accounting for 9.5 million and exports for 5 million bales. Therefore, on August 1, of this year we can anticipate about a 5 million bale reduction from the 16.6 million carryover of last year. This is indeed heartening news for, to be perfectly frank with you, I was fearful that a continued buildup in the carryover might well topple the whole program.

With the program for this year the same as last, I would expect that with normal production and disappearance at this year's levels, the carryover may be reduced another 2 to 3 million bales at the end of the 1967-68 marketing year. As a result, our carryover at the beginning of the 1968 crop year could be between 8 and 9 million bales. This is more nearly what we consider a normal carryover.

Please understand that this is the shakiest of forecasts. At this time no one even knows how many acres will be planted to cotton in 1967, to say nothing of prevailing weather conditions during the growing season.

However, I do want to make clear that it is possible within the next 2 years or so that the cotton industry will have removed itself from the shadows of the huge surplus existing in 1966.

This same situation also prevailed in wheat and feed grains a few years ago. At that time there were huge surpluses of grains. Now we no longer have a surplus. Acreage allotments for wheat have been increased by about 30 percent this year, and the 1967 feed grain program is designed to obtain 12 to 15 million more acres of production. Prices for these commodities are now showing market strength for the first time since the Korean war. Cutbacks in acreage in past years did have some adverse effects on local economies - but, today this is all changed.

It is my hope that the cotton program will also be back to normal within the next year or so. In any event, I sincerely anticipate that a more moderate program will be forthcoming next year. I know that the Secretary of Agriculture is entirely sympathetic to the travails agribusiness is now experiencing. I know that he will do what he can to foster an improved rural economy. Therefore, my hopes are high.

I want cotton to be "out of the woods" by 1969, when Congress will again consider cotton legislation.

As you know, there are many conflicting views within the cotton industry as to the direction any program ought to take. There are pulls from many sides. There is strength in many of the arguments. For example, the textile mills want low prices. The cost of the program to the government dictates a tightly controlled program, while your industry, as well as others, would support increased production. Somehow or other Congress must consider these differing views and reach a decision which will be in the best interests of the industry as a whole.

I do not wish to appear too optimistic at this time, but with surpluses reduced to manageable levels I can see a new program aimed at expansion rather than contraction.

At the present time cotton is moving to the more efficient farms within States. For example, the Department reported that under the allotment transfer provisions of the 1965 Act about 1 million acres have been sold or leased to other farmers in the county or state. With the known technology that we have at hand, production costs can be reduced. Better varieties of cotton are being developed. Great strides are being made in developing new treatments for cotton cloth which enhance its desirability and make it more competitive with synthetics. The new research and development program ought to add impetus to these improvements.

But we must not forget that improvements are also occurring in the manmade fibers; that production in other countries of the world will continue to increase; and that the competition with our cotton will become more intense.

Nonetheless, I can see a brighter future in the making for cotton. As I have indicated, a more aggressive export program on a continuing basis is a necessity. I think one can be developed. I also feel that our domestic markets can be expanded. These are the two major points which I shall strive for in any new legislation. In the meantime, I want to assure you that I shall do whatever possible to insure a strong and viable cotton economy.

Session II

Dalton E. Gandy, Chairman

FACING THE FUTURE--ANALYSIS OF PRESENT PRACTICES IN COTTON SEED MILLING AND PROBABLE CHANGES AND TASKS FOR THE FUTURE

by

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My subject, "Facing the Future--Analysis of Present Practices in Cottonseed Milling and Probable Changes and Tasks for the Future" covers a lot of ground. Cottonseed as a byproduct of lint or cotton has its disadvantages. As I have said before, cottonseed and its products do not have as many problems at this time as the lint. The 1966 and 1967 crops being reduced drastically because of surplus cotton indicate that we have a volume problem over which the seed itself has no control. Further, in thinking of improvement of cottonseed products, more particularly protein, we probably would have had glandless seed years and years ago if it were the seed only that we need consider, but again the lint was and is the biggest factor. The grower must be convinced that the variety will make him the most money from the lint standpoint before he considers too much the quality of the seed.

Having just returned from the annual meeting of the National Cotton Council, I must say that among both private and Government groups there was a strong note of optimism for the future of cotton. It is hoped that in 1968, or soon after, we can again grow the volume of cotton that is needed for a healthy cotton and cottonseed economy.

Now, for analysis of present practices and with the prophecies of the future, I would venture the opinion that the cottonseed mills are not standing still. Even with reduced volume of cottonseed, they are trying to find ways of milling at a lower cost per ton and upgrading the products. Sometimes it seems too slow. Take the linters--I fear in this department that we have made too little progress since the turn of the century. Sure, the linter frame is made of steel instead of wood, and there are more saws per linter, but other than that we haven't done much. I guess we are handling the first, second, and third cuts with air instead of hand labor as we did in the 1900's, but we have this air-pollution problem. Some day we are going to have to correct it. Too often we are forced by an agency of the government, municipal, state, or national, to clean up, when we should do it on our own. There is and there have been thousands of tons of fine lint blown into the air, when its recovery would not only have kept the neighborhood clean, but it would have meant extra dollars in mill products. I hope the Southern Regional Research Laboratory, or someone, will come up with the solution to this problem.

Now in the extraction, I think we have made definite improvements and have replaced the old hydraulic presses with their hand labor to the chemical or solvent extraction plants wherein we not only do it more economically, but we produce an oil and a protein with no chance of contamination. A number of mills have made additions wherein they produce first refined oil or even salad oil in one operation, and it is never touched by the human hand. So I would say for present practices, we have made improvements from the receiving of the seed through the milling of the products, but we haven't made enough.

For the future, I am hopeful that a cottonseed oil mill can operate in the best residential area of the best shopping center and never be considered objectionable. I am hopeful too that in some way, and somehow in our delinting of seed there will simply be a first process to its final end use. The solvent extraction plants need to be made safer and made to require less man-hours and to produce an end product that could be packaged for consumption by anyone in both the domestic and the foreign markets.

Undoubtedly cottonseed oil mills will tend more toward vegetable oil mills, processing two or more oilseeds, but still I think there is a great future for cotton and for cottonseed and its products. We need to convert cottonseed meal to human use as fast as possible, and we need to make all of our products better.

GLANDLESS COTTONSEED--STATUS OF DEVELOPMENT AND PROCESSING

by
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The effects of gossypol and gossypol-like pigments, polyphenolic compounds synthesized and stored by species of the genus Gossypium, upon the color of cottonseed oil and upon the value of cottonseed protein for monogastric animals have been extensively documented in the literature. Boatner (3) reviewed these pigments and their storage in so-called "glands" in the cottonseed. These pigment glands are dispersed throughout the embryonic cotyledons and hypocotyl of the cottonseed kernel and may be observed as dark specks in a cross section.

The gland wall is composed of six to eight cell plates which remain intact upon exposure to most solvents, such as commercial hexane; but they are highly susceptible to rupture by water, especially at elevated temperatures.

While the pigments of the glands are not soluble in water, the entrance of water into the gland, following rupture of the gland wall, causes the pigments to be expelled in rapidly moving streams of finely divided particles.

Pons and others (26) demonstrated that the gossypol content of cottonseed is influenced by both climatic environment and heredity. The Hopi cotton of central Arizona was shown by Lewton (16), and Fulton (6) to have variable numbers of pigment glands.

McMichael (18), reported that selections from the variety Hopi Moencopi had boll and leaf gland content reduced almost to zero. He used the character as a genetic marker to study natural crossing. By crossing Hopi M to upland varieties he was able to produce glandless seed (19). Later, he reported (20) the glandless seed character to be the expression of two recessive genes--gl_2 and gl_3. It was shown that the earlier glandless leaf character was inherited from the recessive gene gl_1. Lee (14, 15) reported three other recessive genes that contribute to glandlessness. Roux (27) hypothesized that the glandless genes 2 and 3 were partly dominant, but the studies of Lee (14) and Miravalle (23) support McMichael's recessive hypothesis. Roux's conclusions may have been influenced by the presence of dominant genes $Gl_{4,\ 5,\ \text{or}\ 6}$. It is generally agreed that a plant homozygous for gl_2 and gl_3 produces seed free of pigment glands. It may be of practical importance to breeders that Fuchs (5) has observed that a heterozygous Gl_3gl_3 may fail to show seed glands unless one of the modifier dominant genes is present.

Many breeders had begun a program to incorporate glandlessness into their varieties before McMichael published in 1960 (20) on how the character was inherited, but progress was slow. Work by Miravalle and Hyer (24) showed how the double heterozygote for the two and three genes could be recovered with a saving of a segregating generation for each backcross. A conference held by the United States Department of Agriculture, Mississippi Agricultural Experiment Station, and National Cottonseed Products Association (30) appeared to create a better understanding of the most suitable breeding procedures.

Several obstacles have appeared to restrict breeding progress to some degree. First, improvement in fiber quality and yields have had to be given preference over glandlessness in an effort to keep fiber competitive. Second, most breeders have always been "a step behind" with their glandless lines because they have been attempting to incorporate the character into existing varieties at the same time they are conducting separate programs to improve the yields and fiber quality of those glanded varieties. Finally, most breeders have been convinced that their individual release of a glandless line would be of questionable economic advantage to them because it is realized that glandless seed will have to be produced in large separated volumes to enable the mill to keep it uncontaminated with glanded seed and thereby create margin between the price of glandless and glanded seed. Nevertheless, excellent progress has been made. Glandless cotton was grown commercially for the first time in 1966. It will be increased in 1967.

Harper and Gandy (7) have reported that 22 breeders, representing all of the commercial types of cotton, are working with glandless materials. One breeder will be increasing seed on 1,500 acres and another on 1,000 acres in 1967 for commercial release in 1968. Seven other breeders will be increasing seed on 20 to 65 acres. Thirteen report that their best glandless lines appear to be equal to their best glanded lines and six others will begin extensive yield and fiber testing in 1967. Nineteen breeders are continuing to grow two generations of breeding materials annually by using the Iguala, Mexico, Winter Breeding Station.

As early as the 1960 crop year the Association and research organizations with whom it was cooperating began to obtain small lots of glandless seed for laboratory processing to determine the quality of the products that might be produced. These small lots were seed that had been discarded or that were in surplus in the breeding program at the U. S. Cotton Field Station, Shafter, Calif. They represented a conglomerate of lines with Acala background. Processing was done at the Cottonseed Products Research Laboratory according to the procedure described by Lawhon and Wamble (13) for hexane extraction and at the Southern Utilization Research and Development Division according to the procedure described by Mann, and others (1962), (21) for hexane-acetone-water extraction. Results were highly favorable to glandless seed.

Thaung and others (29) found that, under conditions of cold-press processing, glandless seed oil had essentially the same characteristics as glanded oil except for a lighter color. Williams (32) reported evaluations of laboratory-processed glandless and glanded cottonseed oils and a plant lot of glanded cottonseed oil produced in the same geographical area. Color was found to be progressively higher from laboratory glandless to laboratory glanded to commercial glanded oil. Stability was equal in all three lots. Iodine number was significantly higher in the glandless oil as was linoleic acid content. Aines (1) confirmed the higher iodine value and linoleic acid content of the glandless oil. He pointed out that the same observation had not been made in earlier comparisons of glandless and glanded cottonseed oils.

Simmons (28) compared laboratory processed glandless and glanded cottonseed oils, which had been stored in the oil-rich miscella at the Cottonseed Products Research Laboratory, under ambient temperatures for a period of almost 2 years. He found that the glanded oil had developed a high-bleached color and off-flavor, while the glandless oil had retained its low color and exhibited prime flavor.

Johnston and Watts (11) compared glandless and glanded cottonseed meals laboratory processed with and without heat by hexane and hexane-acetone-water extraction and an "average" quality commercial prepress solvent glanded meal. All lots were fed in a "practical-type" 21-percent protein ration, with and without 0.3 percent added lysine, to chicks. Lysine supplementation gave a response in all rations, but it was greatest with the commercial glanded meal and least with the glandless meals. Lysine supplementation at this level failed to fully overcome the effects of gossypol in the glanded meals. Mixed solvent extraction, as compared to hexane extraction, appeared to produce higher quality meal for chicks with either glandless or glanded seed. The authors concluded that the glandless meals prepared by either hexane extraction or mixed solvent extraction were equal to soybean meal.

Heywang and Vavich (10) found that laboratory processed glandless cottonseed meal, prepress solvent glanded cottonseed meal, soybean meal, and mixtures of the cottonseed meals with soybean meal were all equal for laying hens except for stored egg quality. Glanded cottonseed meal, fed alone, caused a progressive increase in yolk discoloration as storage times increased, and reached 88 percent at 6 months; but the glandless meal caused only 2 to 3 percent of the eggs to be discolored after 6 months of storage. Slightly earlier studies by these authors (9) generally support those observations.

Lyman and Hale (17) compared laboratory processed glandless and glanded and prepress solvent glanded cottonseed meals, with and without lysine supplementation, to soybean meal in growing and fattening swine rations. Gains and feed efficiency from the glandless meal without added lysine were almost equal to soybean meal and superior to either of the glanded meals. Lysine did not affect glandless meal gains but significantly improved feed efficiency over that of the soybean meal. Supplemental lysine significantly improved the glanded meal rations.

Anderson and Warnick (2), using a semipurified ration for chicks, found that lysine and methionine were equally limiting amino acids in laboratory processed glandless meal. In both laboratory and commercial glanded meals, lysine was the first limiting amino acid. Methionine, isoleucine, threonine, and leucine were deficient in that order. They concluded that glandless meal is a better source of these amino acids than are glanded meals. With amino acid supplementation glandless meal performance was equal to that from soybean meal supplemented with methionine.

Farr (4), working with a laboratory glandless cottonseed meal in a 21 percent protein practical-type ration for chicks, reported that lysine was the major limiting amino acid. His results differed from those of Anderson and Warnick (2) in that no response was obtained from isoleucine supplementation and threonine addition depressed gain and feed intake. He concluded that under his conditions glandless cottonseed meal used was not equal to soybean meal and proposed that an amino acid imbalance might be responsible. However, subsequent studies by Watts and his coworkers (31) showed that supplementation of soybean meal with amino acids, which are in excess of soybean meal levels in cottonseed meal, failed to depress performance. There is a possibility that the glandless meal with which Farr (4) was working contained some of the so-called "heat-labile" factor described by Johnston and Watts (12), which they hypothesized might be eliminated by altering the protein from the alpha-form to the beta-form by heating flakes to 82° C. for 10 min. and 107° C. for 20 min. at a moisture level of 14.5 percent before extraction with hexane or by extraction with a mixture of acetone-hexane-water with or without heat.

Hill and Totsuka (10) determined the metabolizable energy values of glandless cottonseed meal, commercial glanded meals, and soybean meal. They found that "good" glandless and "good" glanded meals had comparable values. Excessive levels of free gossypol and lack of moist heating of glandless meals reduced metabolizable energy.

During the 1965 crop season, arrangements were made with the U. S. Cotton Field Station and the Camp Ranches of Shafter, Calif., to grow a block of glandless Acala 4-42-77 cotton to provide seed for a mill-processing test to determine whether glandless seed would perform as well under commercial conditions as it had with laboratory processing.

The glandless cotton planted was a mixture of discarded advanced lines which had been increased from the breeding program. Presumably, little cross-pollination occurred with glanded cotton and care was supposed to have been taken in ginning to avoid mechanical contamination. The seed were essentially free of gossypol, but six composite grab samples taken after delinting ranged from 0.008 to 0.020 percent total gossypol and averaged 0.012 percent total gossypol. Apparently, some glanded or part glanded seed were present.

The decision was made to process the seed in a direct solvent extraction plant because it was known that optimum protein availability cannot be achieved even in the absence of gossypol, if processing heat is drastic (Martinez and others (22)), and because it was desired to reduce residual oil to a low level. The Leland Oil Works, Leland, Miss., made its processing facilities available and gave excellent cooperation in planning for and conducting the processing test. It was necessary to attempt to process by predetermined conditions, because the capacity of the mill was about 150 tons and the supply of seed was only 40 tons.

Therefore, considerable handicap was involved since the mill had to be started up "cold" after stopping for cleanout.

It was intended that the procedure follow as closely as possible the conditions described by Lawhon and Wamble (13) which are outlined in figure 1.

There are certain distinctive differences between mill procedures and those followed by Lawhon and Wamble (13). In the laboratory the seed was flaked before cooking, whereas, in the mill it was necessary to condition, or "cook", before flaking. Laboratory cooking of flakes was 10 min. at 180° F. followed by raising the moisture content to 12 percent, cooking further for 20 min. and reaching a maximum temperature of 225° F. In the mill, attempts were made to raise moisture to 12 to 14 percent by addition of water in the top ring and to bring the temperature up to approximately 225° F. in the bottom ring. These efforts were unsuccessful. The processing log shows that the meats remained in the conditioner for 30 min. as planned; the temperature reached 217° F. during the first period, declined gradually to 175° F. in the fifth period, and rose to 213° F. in the last period. The moisture content of the meats before they entered the bottom ring ranged from 8.90 to 10.24 percent, averaging 9.48 percent. Very likely some moisture "flashed" off before the sample container could be sealed, but it did not reach a level of 12 percent. There is some doubt that there was as thorough penetration in the mill as in the laboratory flakes.

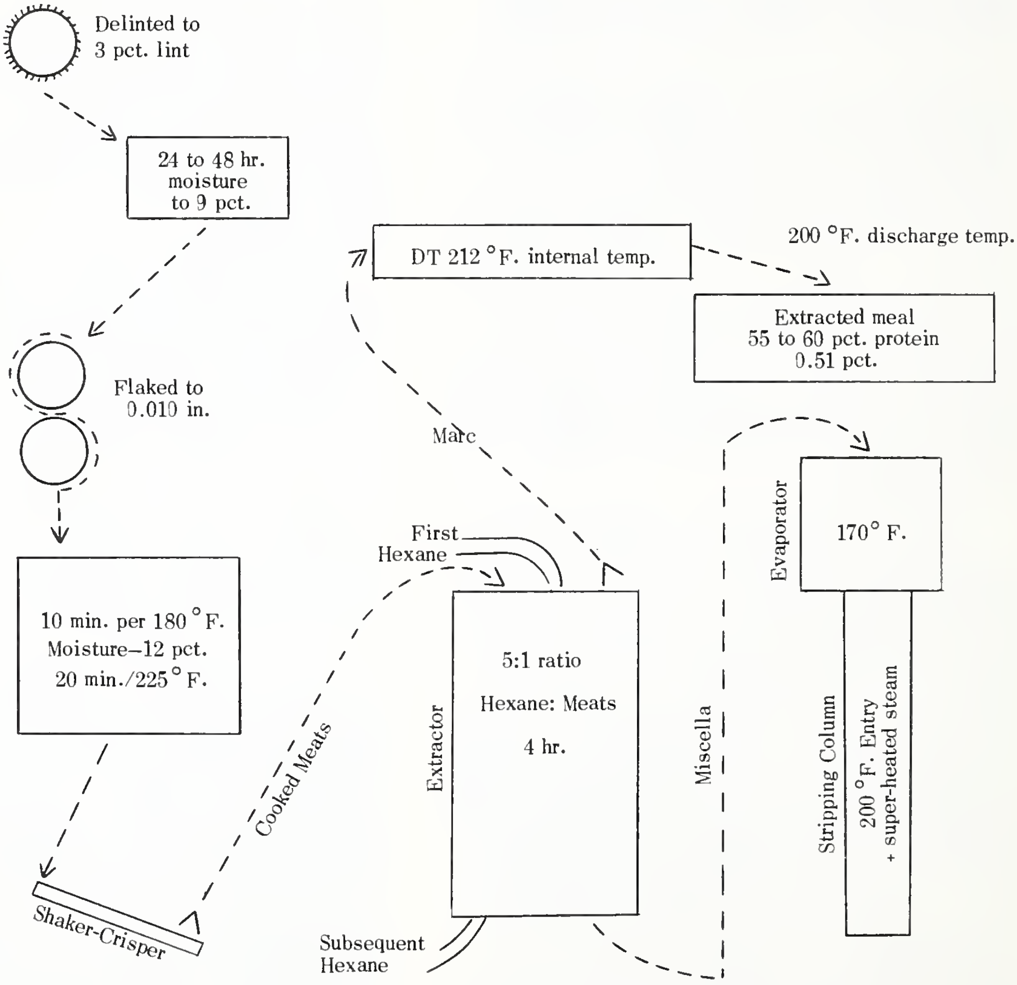

Figure 1.–Laboratory extraction of hexane at the Cottonseed Products Research Laboratory.

In the laboratory extraction, cooked flakes were crisped by belt cooling; whereas, in the mill the flaked meats after conditioning went directly into the extractor.

Maximum temperatures reached in the mill meal desolventizer averaged about 5° F. higher than estimated temperatures in the laboratory desolventizer. Maximum temperatures in the mill oil desolventizer averaged about 34° F. higher than in the laboratory oil desolventizer.

One ton of the glandless seed was shipped to the Cottonseed Products Research Laboratory (CPRL) and processed by the procedure shown on the flow diagram. Also, samples of glanded meal produced by the Leland mill immediately before and immediately after the processing of the glandless seed were analyzed for comparisons. These, with other criteria, help to show the response of the glandless seed to the commercial processing conditions which existed during the test.

Phelps (25) has reviewed the good relationship of nitrogen solubility and EAF lysine to the biological value of cottonseed meals. Figure 2 shows the progressive increases in the values from the glanded meal processed at the Leland mill to the glandless meal processed essentially in the same manner there to the laboratory processed glandless meal. Significant improvement resulted from the use of glandless seed, but still further improvement can be achieved.

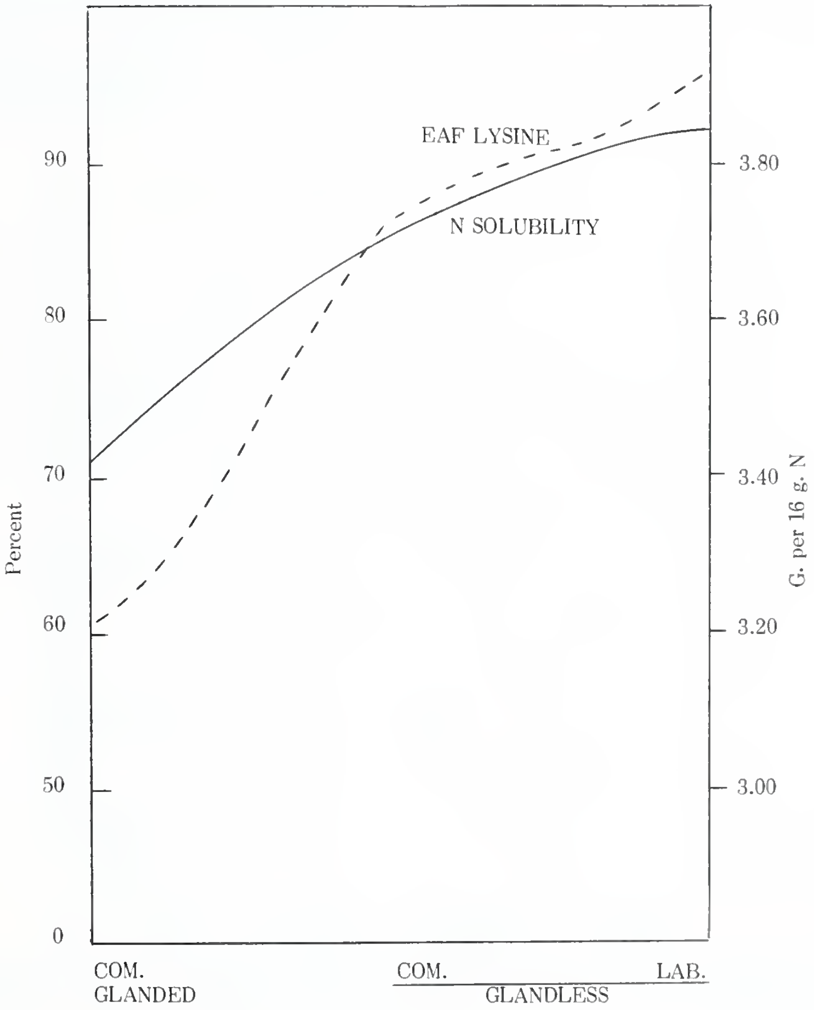

Figure 2.--Nitrogen solubility and available lysine of glanded and glandless cottonseed meals.

Figure 3 shows the effects of each laboratory processing step upon the nitrogen solubility and EAF lysine of these glandless materials. Values for both criteria increased up to the time of flaking and decreased during cooking and/or desolventizing or both.

Figure 4 suggests a generally good correlation between processing heat during the six processing periods at the Leland mill and the nitrogen solubility of the flakes after cooking and the meal after desolventization. The solubility value for the flakes at the first period is in conflict with the meal value and with the trend in cooking temperature. It is entirely possible that this conflict may be the result of gossypol contamination after cooking. This point will be discussed further later.

Data from the laboratory processing are plotted on the right of the graph. As has been mentioned earlier, cooking temperature was higher in the laboratory and DT maximum temperature was slightly lower. Yet, the nitrogen solubility of the flakes and the meal was significantly higher from the laboratory than from the commercial mill. Two possibilities for the cause of this difference appear to exist. One may be gossypol contamination of the mill samples and the other may be differences in moisture levels.

An interesting point in figure 5 is the relatively high gossypol content of the meal sample from the first period at Leland as compared to the flakes for that period. Later, you will see the same relatively high gossypol content in the first oil sample. It appears that residual glanded materials in the system, perhaps predominately in the extractor, were being mixed with the glandless material. This hypothesis is supported by the fact that levels in the commercial

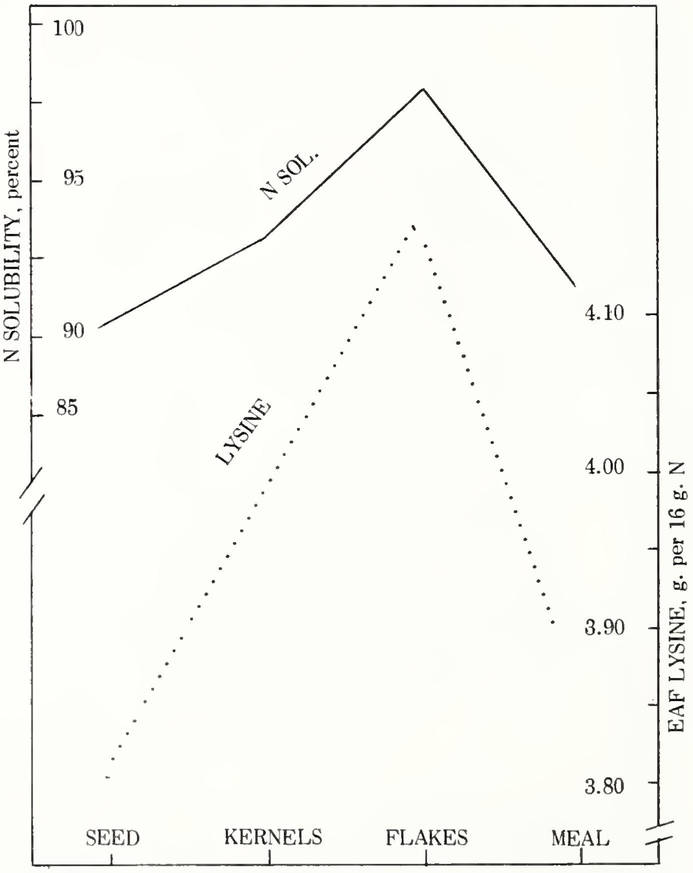

Figure 3.--Effects of processing upon EAF lysine and N solubility of glandless cottonseed meal (Cottonseed Products Research Laboratory, 1966).

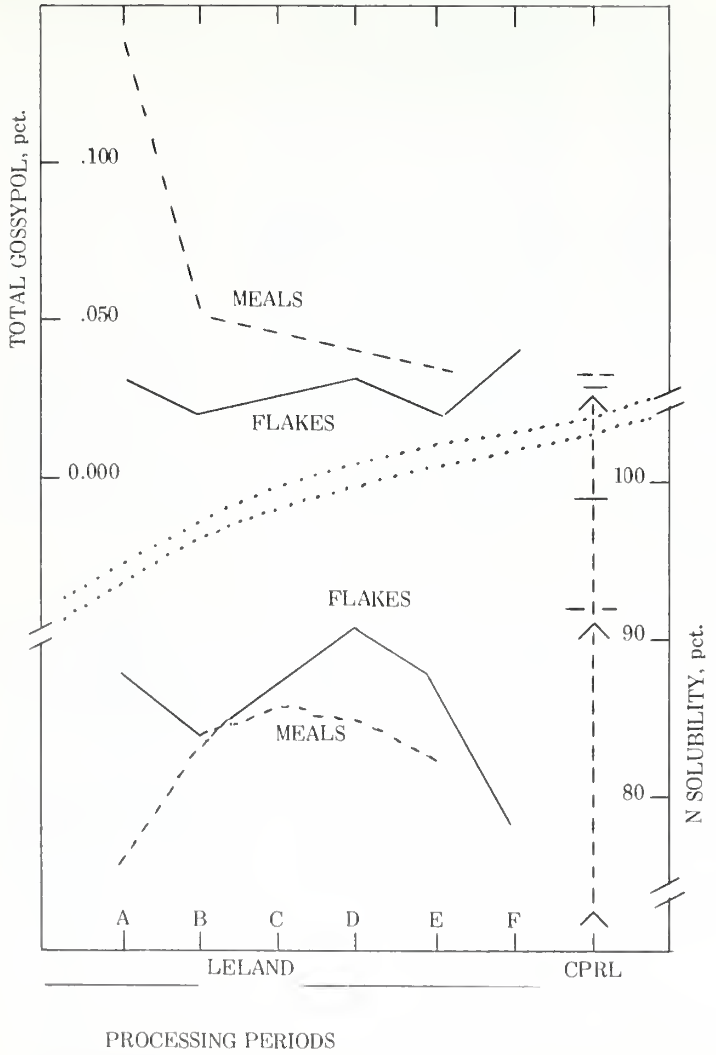

Figure 5.–Relationship of total gossypol to N solubility of glandless cottonseed meals in Leland mills and CPRL.

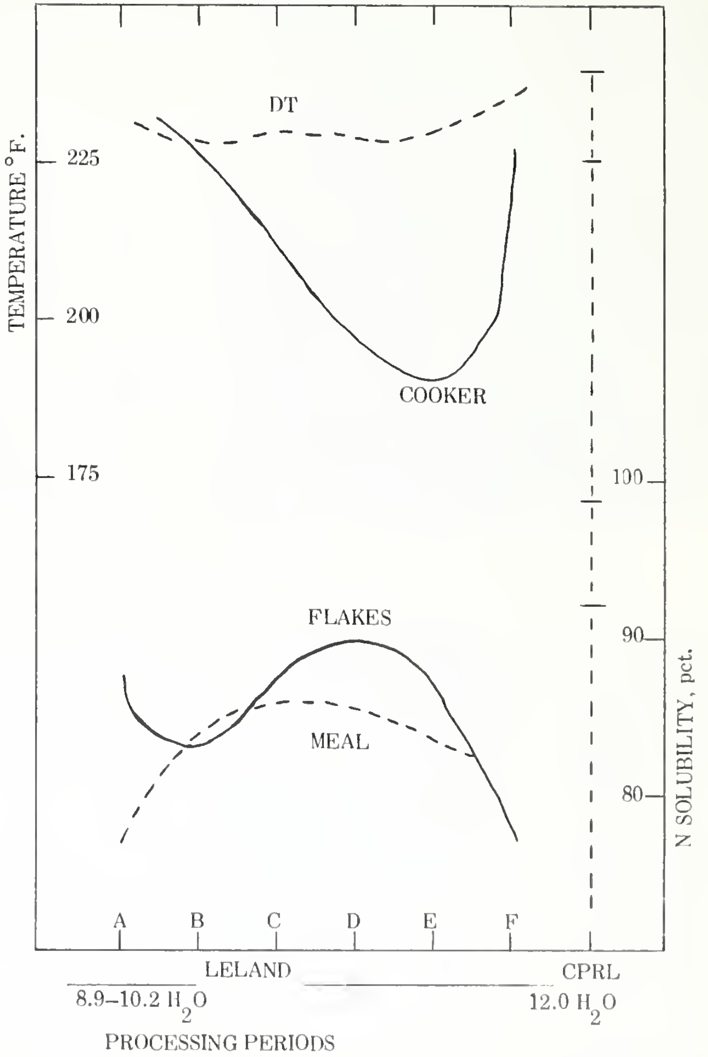

Figure 4.–Relationship of processing heat to N solubility of glandless cottonseed meals at the Leland mill and Cottonseed Products Research Laboratory (CPRL).

plant were approaching those of the laboratory near the end of processing. Yet, the nitrogen solubility curves had turned downward at the end of processing. We may have to assume that three factors--gossypol, temperature, and moisture--were all participating.

In figure 6 we see an excellent correlation between gossypol content of the crude oil and its refined and bleached colors. The laboratory processed samples, which are connected to the mill samples by the broken lines, fit the pattern well. The mill oil values had decreased in samples C and D to the level of the laboratory sample. Then, with a sudden rise in gossypol content the mill sample E showed higher color.

In figure 7 there is superimposed the cooking temperatures at the Leland mill. Obviously, this curve lacks the correlation which the gossypol curve has to oil color. While oil color decreased as cooking temperatures dropped during the first part of processing at Leland, subsequent conflicting trends negate the relationship. We can conclude that gossypol was responsible for the oil color. The enigma is whether the seed varied sufficiently in gossypol content or whether residual glanded materials in the system are primarily responsible. If we go back to our curve on gossypol content of the cooked and flaked materials, it appears that residual gossypol from the processing system was more likely the cause.

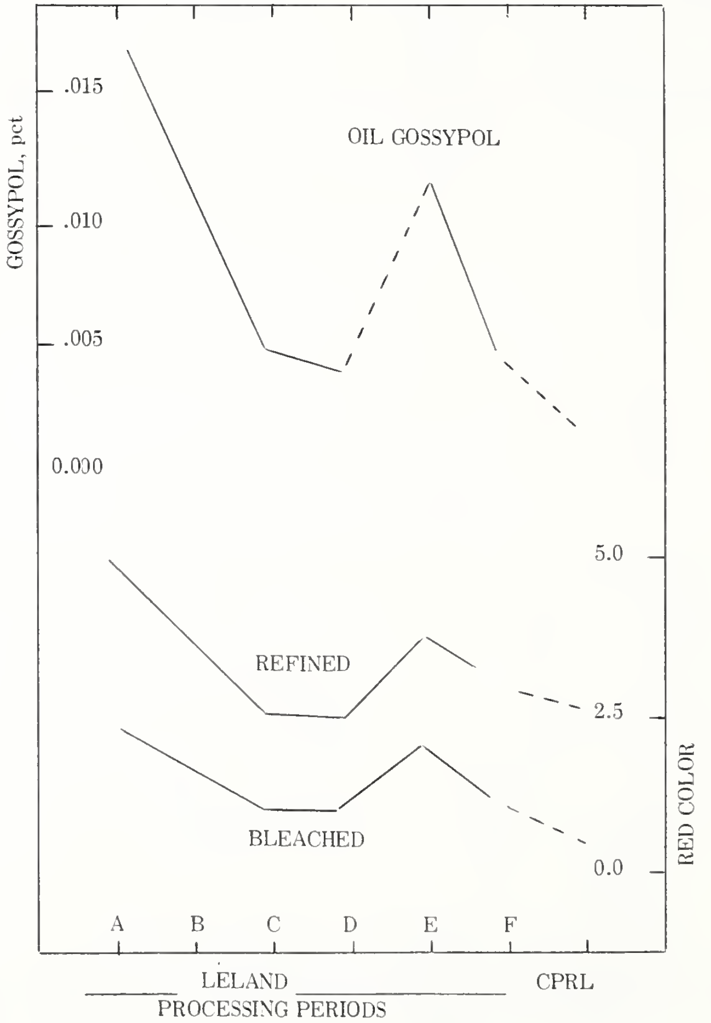

Figure 6.--Relationship of gossypol content to oil color in Leland mill and laboratory (CPRL) "glandless" oils.

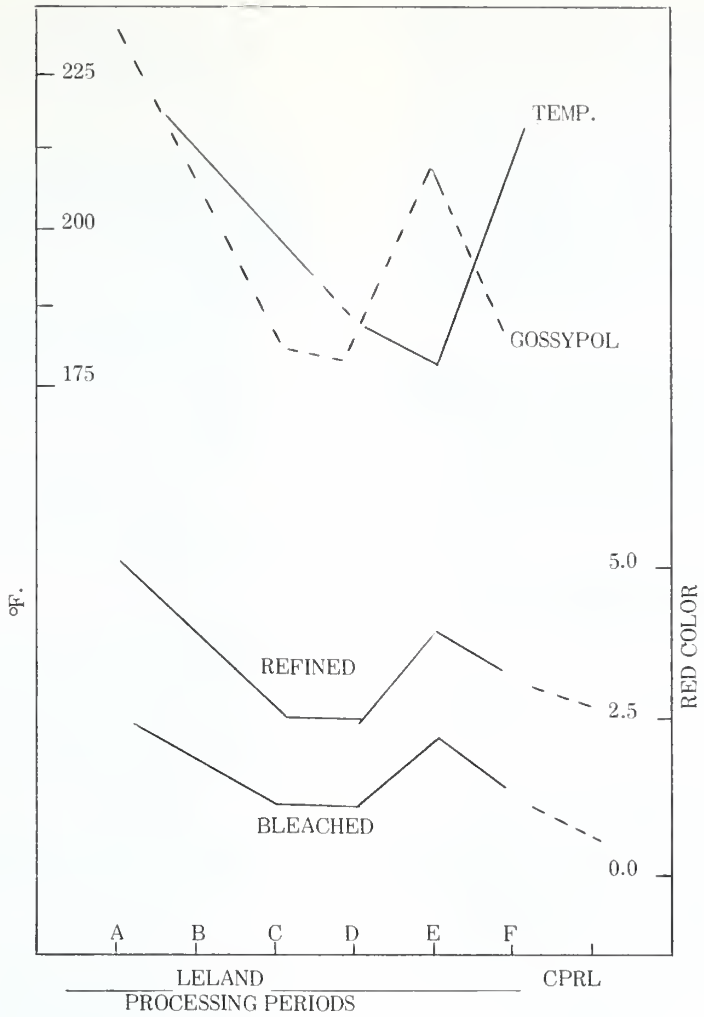

Figure 7.–Relationship of cooking heat to color of "glandless" oils at the Leland mills and CPRL.

The average free-fatty acid (FFA) values of samples of oil from the six processing periods immediately after processing was 0.38 percent. Seven of the original 30 drums of oil were removed for various studies. The remaining 23 drums remained in storage under ambient temperature for approximately 10 mo. and the free-fatty acid content of a composite sample at that time was 0.4 percent. The original Lovibond color for refined oil was 3.5 red and the value after storage was 3.2 red.

Refining loss of glandless oil at about 8 percent, as determined by the official cup method, is obviously too high considering the low FFA and color values. One would expect refining loss to be lower with glandless than with glanded oil because refining removes gossypol. However, glandless oil tends to emulsify in the cup test with the resulting loss of triglycerides in the soapstock. Methodology for determination of refining loss will probably have to be changed for trading in glandless oil.

Products from the processing of the glandless seed at the Leland mill are on test at the present time and results will be reported later.

In 1966 the Gregg Seed Farms released to growers in the South Plains area of Texas a glandless variety identified as Gregg 25V. Like other cottons in that area yields were greatly reduced by an early October freeze. However, approximately 600 tons of seed were harvested and ginned separately for processing at the Plains Cooperative Oil Mill in Lubbock, Tex. A portion of the seed and meal will be tested by private and public groups. The major part of the seed will be processed in March or April for use in human foods. All systems in the mill will be thoroughly cleaned of residual materials prior to processing. Trial runs with glanded seed will be made to produce meal or flour of the highest practical protein content, lowest residual oil, least processing heat damage, and greatest freedom from microorganisms.

Specifications for cottonseed flour for use by UNICEF in human foods are given below. Many of these specifications can be easily surpassed when glanded seed are used. The sanitation specifications are very rigid and must be given careful consideration.

UNICEF COTTONSEED FLOUR SPECIFICATIONS

I. General:

Seed

1. Foreign matter, 1.0 percent maximum
2. Moisture, 12.0 percent maximum
3. FFA, 1.8 percent maximum
4. Discolored seed, 5.0 percent maximum
5. Aflatoxin, negative

II. Analysis:

1. Moisture, 10 percent maximum
2. Crude fat, 6.0 percent maximum
3. Protein, 50.0 percent minimum
4. Crude fiber, 5.0 percent maximum
5. Total gossypol, 1.2 percent maximum
6. Free gossypol, 0.06 percent maximum
7. FFA, 1.8 percent maximum
8. EAF lysine 3.6 g. per 16 g. N minimum
9. Nitrogen solubility, 65 percent minimum

III. Sanitation:

1. Bacteria count, 20,000 per g. maximum
2. E. Coli, Salmonella, and pathogen free
3. Acid insoluble ash, 0.1 percent maximum
4. Insect and rodent contamination free

The specifications that have been established for soybean flour for use in blended mixtures purchased by the government for use in the Food for Peace Program are given below.

FOOD FOR PEACE SOYBEAN FLOUR SPECIFICATIONS

I. General:

Sound, cleaned, dehulled beans; hexane extracted, desolventized, deodorized, toasted to light yellow or golden buff.

II. Analysis:

1. Moisture, 10 percent maximum
2. Protein, 50 percent minimum
3. Crude Fat, 2.0 percent minimum
4. Crude Fiber, 3.5 percent maximum
5. Ash, 6.5 percent maximum
6. Particle size, 95 percent through No. 200 U.S. Standard wire mesh sieve
7. Antioxidants, 2.5 mg. per 100 g. each of butylated hydroxy anisole and butylated hydroxy toluene
8. Nitrogen Solubility, index 10, 30 percent minimum
9. Urease Activity, 0.05 to 0.15 increase in pH

III. Sanitation:

1. Bacteria Count, 50,000 per g. maximum
2. Negative insect and rodent contamination

There appears to be a very promising future for glandless cottonseed protein in human foods and for industrial uses because of its freedom from gossypol, less danger of damage to its protein quality and lighter color.

Summary

Glandless cottonseed which is essentially devoid of gossypol--a principal barrier to extension of the usefulness of cottonseed protein and oil--has been developed relatively rapidly to the point that it closely approaches and, in some instances, equals the agronomic characteristics of presently grown glanded cottons. Studies with laboratory processed glandless products have demonstrated their outstanding value. Glandless seed have been processed in a commercial mill with a large measure of success despite severe handicaps imposed by the limited tonnage. Commercial production of glandless cotton on a limited scale has become a reality in one geographical area. More comprehensive mill scale processing is planned for the immediate future.

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PANEL DISCUSSION: PROCESSING BY SOUTHERN OIL MILLS

Roy Castillow, Presiding

REASONS FOR CONVERSION TO STRAIGHT SOLVENT EXTRACTION WITH EXPELLERS ALREADY INSTALLED, AND RESULTS NOW BEING OBTAINED

by
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Planters Manufacturing Company
Clarksdale, Miss.

We were asked the reason for conversion to straight extraction with expellers installed and the results now being obtained. Just prior to installing direct or straight extraction, we had, for a number of years, used the prepress method of extracting cottonseed through our Anderson plant which normally handles soybeans.

Through this experience we had gained a sizable knowledge of the advantages and disadvantages of prepressing. For example, we knew that the oil recovery on prepressing was 0. 3 to 0. 5 of 1 percent lower than by straight extraction, that there was a small difference in the quality of the oil and meal, and that the cost of installing an extraction unit would not be as involved when it was to be supplemented by expellers or screw presses.

However, there were many factors to be considered. In view of the apparent decrease in the availability of cotton acres and the substantial increase in the soybean production in our area, we needed a flexible extraction unit that could crush enough cottonseed daily that would equal the capacity of our lint room, and one that could readily be adaptable to crushing over 300 tons of soybeans a day.

Such an installation, along with our present extraction unit, could convert over 500 tons of soybeans daily. Knowing the preparation equipment for both cottonseed and soybeans were similar, it appeared as though this would be the feasible solution to our problem.

On the other hand, having no applicable knowledge about straight extraction, it was, therefore, necessary to look at the production costs and savings of both systems.

Due to the particular layout of our plant, it was necessary to station a man in the cooker room, one in the expeller room, and one to help with the filter press and to do other related work. In addition, it was necessary to have a maintenance crew to repair and maintain the machinery.

Under straight extraction, however, the cottonseed meats would leave the hullers and separators and go directly to the solvent plant prep room where the plant operator could solely administer to the preparation and extraction by himself.

It was believed that a minimum of three men per shift, or nine men per day, would be reduced by utilizing the straight extraction method. Also, by training the expeller operators to run the solvent plant, it would not be necessary to bring in other personnel for training and these operators could take charge of their own maintenance, thus eliminating another maintenance crew.

By doing away with the departments previously mentioned, we could remove two sets of five-high rolls, two-five-high 85-in. cookers, five expellers, and all the conveying systems to this machinery thereby reducing some of the cost of installing the straight extraction system.

Also, by removing this equipment, the replacement maintenance cost in repairs would afford additional savings, and our steam consumption rate would be reduced by discontinuing our cooking operation.

An important factor to be considered is that removal of the expellers and cookers would reduce our electrical load by roughly 500 hp. Calculated at our present power rate, for every 100 kw. of our peak demand savings in the amount of $2, 000.

This is doubly important because at the time cottonseed are being processed our kilowatt load is highest. Therefore, our peak demand is set, thus establishing our kilowatt rate for the entire next 12-mo. period. This cuts approximately 500 hp. off the peak load, which represents a reduction in power costs of $10, 000 a year.

Two other points that are fundamentally important, but on the other hand difficult to evaluate, is the removal of so-called "bottlenecks" which cause breakdowns and down time in production.

Such nuisances are important to all of us and are certainly a deterrent to an efficient well-run operation. In our case it was felt that discontinuation of the expellers would eliminate the most troublesome phase in our production flow.

The other point involves the all important job of "cleaning up." It has been our experience that it is a much simpler task to maintain conditions that meet with the Food and Drug Administration approval when operating on straight extraction rather than prepressing.

In other words, we were able to remove many areas classified as "static" areas, which were extremely difficult to clean up and maintain. Now, we are able to clean up our production departments in a much shorter period of time, thus omitting further down time and additional labor costs.

Now as to results, and this is more or less based on seed with an average acid of 1. 5 percent, we have been extracting an oil with 0. 8 to 1-percent residual, a refining loss of around 7 with a color of 6, all of which is somewhat higher as opposed to prepressing.

But, when this small difference is weighed against substantial savings in labor, maintenance costs, power, and steam costs, down time and clean-ups--added to the fact that we have found an available market for our product--there is no question that in our case the proper decision was reached and the answer to our problem was obtained.

COST AND PROBLEMS, IN INCREASING SOLVENT PLANT CAPACITY FROM 300 TONS PER DAY TO 400 TONS ON COTTONSEED, AND RESULTS NOW BEING OBTAINED

by
Jack Hughes
Yazoo Valley Oil Mill, Inc.
Greenwood, Miss.

The subject of my talk is "Cost and Problems in Increasing Solvent Plant Capacity from 300 Tons per Day to 400 Tons on Cottonseed and Results Now Being Obtained."

I am not going to talk about the cost. All I am going to talk about is the problems and how we solved some of them. When it was decided to increase the size of the extracting unit to 400 tons, all the piping, baskets, and the whole extractor were cleaned out.

Nothing was left inside it but the four walls; all the pipes were taken down and only the condensers, the DT evaporator, and the extractor walls were left in the building.

All the materials were piled up outside the building in two piles and we sold one pile for scrap iron. The first problem that came up when we got ready to put the extractor together was that parts were either at the junkyard or at the bottom of the big pile.

That was the first problem. If you ever plan on doing this, spread everything out and don't sell anything until you get it all back.

The old extractor had 26 baskets in it; the new extractor, 19 baskets. These baskets have a radius--actually they are in a circle, the walls are--of about 20 in. in diameter out from the center of the shaft. They are 28 in. deep.

We have about a 28- to 30-min. retention time on cottonseed, and each basket holds about 575 to 625 lb. of flakes. Because there are no screens in the bottom of these baskets, we had to put a new type rig in the extractor, known as a full miscella tub.

The first problem we had was getting the hexane into the tub. The screen on the tub was about an 80-mesh and it stayed stopped up. We solved this problem by buying a 50-mesh screen and increasing the size of the tub by about 60 percent.

Then, a different type of filling device was put in. We had a hydraulically operated filling device. We changed to a continuous filling device, and we ran into the problem of the two spouts in the filling device, which go down to fill the baskets, stopping up. If we put hexane in and mixed it with the flakes to keep the spouts open, this beat the flakes up into powder and they wouldn't drain. We finally had to dry the flakes out more than we had been used to drying them. At present, we try to run the flakes at a moisture of about 7.5 to 8 percent.

Drying out the flakes finally solved that problem. Another thing that was added were two rings to the cooker. We already had eight 85-in. rings and we added two 85-in. rings.

We had a 24-in. vent going out the top of the DT to a 72-in. collector added at the top of a 26-in. existing vapor scrubber. Also, the 75-horsepower motor that drives the DT had to be rewound to increase the horsepower.

Now, we put in a new first stage evaporator. The heat for this first stage evaporator is provided by the vapors from the toaster.

In other words, all the vapor from the toaster goes on the outside of the tubes of this evaporator to provide heat.

The vapors that are not condensed by the evaporator go to the DT condenser and the liquid hexane is drained off by a 6-in.-in-diameter line on the bottom.

When you are starting up to provide heat for this evaporator, you have to put live steam on that side. Well, we have problems with that. We have to learn how to run that.

We had operators that would put too much steam on the first stage evaporator and the steam would back right up into the DT and it would act as a condenser, and then we had water in it.

Now, a new final still was added, which is a disc-and-doughnut column, 36 in. in diameter, 30 ft. high. We have had no trouble with this. Our old final still or stripping column is used as a hot mineral oil column, 24 in. in diameter and 20 ft. high.

The new 14-in. cold mineral oil column which was 20 ft. high was added. Later we added 10 more feet onto it.

One other problem we had that was not directly associated with this addition but might come up some time--we have a new lint room, which was built close to our cooling tower. When we first started this new lint room up, we were bothered with the cooling water filling up with lint particles which stopped up all the condenser tubes. We worried with this for about 4 or 5 weeks.

Finally, somebody came up with the idea to screen the intake on the cooling tower. This was done and we have had no more trouble. However, it takes one man about 2 hr. twice a week to wash these screens.

In January we crushed 10,312 tons of cottonseed and used 6,825 gal. of hexane, which is 0.66 gal. per ton.

The average oil in the spent flakes was 0.94. Up until February 13, 1967 at 7:00 o'clock, we crushed 4,202 tons, used 2,590 gallons of hexane, for a loss of 0.62 gal. per ton, with an oil in the spent flakes that averages 1.06.

EXPELLER OPERATIONS AT THE SOUTHERN COTTON OIL CO., INC., MEMPHIS, TENN.-PLANT

by
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The Southern Cotton Oil Co., Inc.
Memphis, Tenn.

I am not going to attempt to tell you all the troubles we had trying to run an expeller room. I'd take a lot more time than Jack Hughes did.

The subject of oil extraction on mechanical presses has been covered by a good number of experienced operators and equipment engineers over the past several years with good publicity coverage.

This review is for the Memphis Plant of the Southern Cotton Oil Company only. It's my belief that no one specific procedure will give equal results in all plants, due, of course, to differences in equipment, throughput, condition of raw material, that is, acid moisture and so on, and plant personnel as variables.

Nor do I believe in any one procedure working continuously at any one plant. However, we do have recognizable operating procedures, or guidelines, within which we may work, adjusting to changing conditions as they come up.

As a matter of record, the Memphis Plant operates eight Super Duo Andersons with four, seven-high, old 85-in. cast iron cookers, and we have three sets of 16 x 60 in. five-high rolls.

Our tonnage range is 320 to 340 tons per day. We add as much moisture ahead of the rolls as they will take, or up to 12 percent. We do not have a conditioner ahead of rolls. We believe that would be necessary on dry CPS, but on dry seed we do add water to the top ring, using a French spray valve with air pressure to disperse the water.

We found steam was too difficult to use and too hard to control for this purpose. A good breakup of water is very important, because the top ring is the point where water balls are formed. We cook in the two top rings, dry in the lower five rings.

Normally we cook with moisture at 12 percent in the top ring. For a continuous cook, the gates are revamped with 5 x 7 opening with float arms extended, on drying rings only, to hand straight down. Meats just cover bottom in rings, and the wave of meats on sweep operates the gates.

This treatment cuts down on short cycling and batching. The top ring load varies from 16 to 20 inches, temperature from 175° to 200°, or according to the acid in the seed and the balance on extraction and refining loss or both.

Top ring temperature is brought up fast. On higher temperatures, the ring capacity is assisted with low pressure, live steam, through a horseshoe header in cooker, 12 in. above the bottom.

The use of live steam is rather controversial, I know. Some operators have divided opinions on it. We do use live steam to assist our top jacket temperature only and then at a very reduced pressure between 2 and 3 lb. per square inch.

The second ring load is 14 to 16 in., temperatures from 210° to 220°. All other rings are loaded lightly, just covering bottom at hubs, with plows on sweep to give live agitation and throw meats back towards the center of the cooker, approximately 7 in. deep. We have one common reducing valve on all five bottom rings.

We come out of the cooker varying from 245° to 255°. The moisture is 2.6 percent to 3 percent, as desired. Cooker retention time is approximately 80 minutes. Now, due to the low level of meats in bottom rings, the recording thermometer is located in the feed conveyer under the cooker.

Screen tank and filter press material is added continuously to cooked meats going to 14-in. conditioners. Press feed is around 250° and has 1.8 percent moisture. That is, plus or minus about 10 percent.

It has been said that preparation is 90 percent and mechanical equipment 10 percent, but certainly press condition is important and must be kept up, but I won't go into that here. An amply adequate supply of cooling oil for the presses is very important, not just enough to wash foots away, but to cool barrels, 50 gal. per min. at approximately 110° as a minimum per press.

We keep a running log book on equipment repairs and operating procedures and find it not only useful but necessary for a constant effort must be made toward uniformity of operation and that all shift foremen are kept aware of procedure and of any necessary changes to follow through on.

As far as temperatures are concerned, only the two are top cooking rings and uniform feed must be maintained so the top ring is fully charged at all times. We have an audible alarm system attached to the top float.

Moisture samples are run on cooker feed meats at regular intervals for uniformity. We try to maintain protein on meats through presses as high as possible, consistent with separation capability.

This serves a double purpose of increased capacity and mill efficiency. Now, all this above must take into consideration the human equation, for a properly trained crew is the most important factor.

SCREW PRESS OPERATIONS AT THE PLANTERS COTTON OIL MILL, INC., PINE BLUFF, ARK.-PLANT

by
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Planters Cotton Oil Mill, Inc.
Pine Bluff, Ark.

Most of you know the subject of my talk is screw-press operations.

I am sure what I have to say will be of little benefit to the old heads in this operation, but I hope I can bring out a few points that will be of benefit to younger groups in this field. Let me also say before I get started with my subject; I am not attempting to deliver an address similar to one that a manufacturer's representative, chemical engineer, or a person in charge of a group of mills would give to you. My discussion will cover one thing at the Pine Bluff Mill. We have worked very hard over the last few years to improve our work and do a better job.

I am sure we all know that the method used at Planters will not work effectively in other plants. The seed in each locality is different; thus, other mills have their own individual characteristics. However, it is possible that some other methods, which I will present today, could be beneficial to other plants. I will make an analysis of the type of equipment used at Planters so that you may have a better understanding of the work that can be done, using our system as an example.

In our mill at Planters, we have one set of five high, 60-in. French Rolls. This gives us fair rolling capacity for the tonnage which is around 220 to 235 per 24 hours.

Thus, our flake thickness is around 10 to 15 thousandths. Although this should be from 5 to 8 thousandths, we think we do a very good job with one set of rolls.

For a short time we had trouble and bypassed the rolls, but our extraction jumped up. So, I am of the opinion that good rolling is necessary to do a good job in the press room.

We have found that in our cookers there is not enough cooking capacity as needed. Since we have speeded the presses up, we carry about as much meal in the top ring as possible and taper off to the bottom. We carry 185° to 190° on the top ring and are gradually increasing the temperatures. In fact, we took the regulators off and ran straight steam lines. We came out of the bottom ring 250° to 255°.

We carry 110-lb. steam pressure on the top ring and 120 lb. on the bottom rings. Moisture is added in the top ring before going to the cookers. All the water is measured to keep a clear check on moisture.

Load on every press is maintained at all times with the highest amps possible.

We have found that cooling the presses is the essential part of the operation. The cooler the press runs, the higher the amps will run.

Our presses are regulated to 125°. We have found that this temperature has resulted in the best operation. We have also found that you should use soft water for good operations with screw presses. We have a French Feeder with variable speed to control the load to the cookers.

If the operation continues with a light load, it will empty the meats bin. This will help keep down any acid buildup.

During this process this bin is emptied several times a week.

We have six French presses with 22 extensions, 100 hp. motors. Speed of main shafts on two are running 40 r. p. m., and two are running 45 r. p. m., feed screw 122 r. p. m. We keep one set of cages filled so that when we see a deficiency in our work we can change out a press from 4 to 6 hr. This does not interrupt our operation but for a short period of time. By this method, some of the presses are in good working condition and our work is more consistent throughout the season.

On our main shaft for prepress, we run at 45 r. p. m. with our feed screw running at a ratio of 4 to 1 with a 4-1/2 in. pitch.

Our A and B combination feed has a 5-1/4 in. body, no collar, and 4 to 4-1/2 in. pitch.

Number one collar is 5-1/4 by 5-1/2 by 3-1/4 in. wide, with the worm being 5-1/4 in. in diameter. Number two collar is 5-1/4 by 5-3/4 by 3-1/4 in. wide with the worm being 5-3/4 in. in diameter. Number three collar is 5-3/4 by 6 by 2-1/2 in. wide with the worm being 5-3/4 in. in diameter. Number four collar is 5-3/4 by 6 by 2-1/2 in. wide with the worm being 5-3/4 in. in diameter. Number five collar is 5-3/4 by 6 by 2-1/2 in. wide with the worm being 5-3/4 in. in diameter. Number six collar is 5-3/4 by 6 by 2-1/2 in. wide with the worm being 5-3/4 in. in diameter. Number seven collar is 5-3/4 by 6-1/4 by 2-1/2 in. wide with the worm being 6 in. in diameter.

Now on a press without the 22 in. extension, this is all you need. We at Planters have the 22 in. extension, so we have more collars and worms to use so we press with the 11 in. nose and 11 in. swing cage off, but due to cleanness we went back to extension as follows:

Collar number one on extension is 6 by 2-1/2 in. wide. Number two collar is 6 by 6-3/8 in. diameter by 2-1/2 in. wide. Number one worm is 6-1/4 in. in diameter. Number three collar is 6-1/4 by 6-9/16 in. in diameter by 2-1/2 in. and we have a 6-9/16 in end.

Now for a press shaft such as this you will have to have a special breaker bar, although we use the same center bar as straight extraction.

On our main cages we have a water cooled insert and we cool our main shaft with water; also, in our auxiliary cage assembly we have a 0. 020 spacing in top and bottom cage. In section A on our main cage we use a 0. 015 section and in B, 0. 015. In section C we use 0. 010 and in section D, 0. 07-1/2; on our 11 in. nose we use . 005 and on our 11 in. swing cage, . 005.

We find that we can do a better job in the extraction plant at this spacing; we leave from 10 to 12 percent oil in cake going to extraction plant. We do this so the distillation equipment will have more work to do.

Our reason for this is, the more oil through the distillation gives us a brighter oil; where, if we took more in the beginning or if we took more oil out in the prepress, we would have a dark oil. I might even say black oil. Our color is around 4. 5 refining loss around 4. 5 to 5. 5. I might state that with more rolling capacity and our cooking greater we could do a better job on color and loss. We run three presses about 75 percent of the time. Sometimes we run four presses, depending on the type of seed we run. We get approximately 75 ton to the press.

In considering our own operation--comparing a straight screw press operation to prepress solvent extraction--we have been able to make these observations. Although we have added cost in the form of additional labor, solvent loss, and depreciation, we feel that these were offset considerably by a reduction in the maintenance costs of our screw presses. Most of our fears of customers acceptance of our products were unfounded. Almost all of our meal is sold as dry meal and in bulk form. The bulk shipments have been a real blessing in disguise, allowing us to operate our meal delivery room with fewer personnel and with a more orderly schedule. We have been able to increase our meal moisture content from 10 to 12 percent with no fear of mildew or caking. We have been able to maintain one-half of 1 percent or less residual oil with minimum solvent loss and no reduction in capacity. It would be a difficult decision today, particularly with rising labor costs, not to consider direct solvent extraction--but with screw presses in place and operating, our prepress solvent extraction system has been a very happy compromise.

DISCUSSION

Question: What is the big advantage of a pneumatic meal cooling conveying system on both cottonseed and soybean meal over other methods of cooling?

Mr. Fleming: You really have two advantages. Although it may be true that your horsepower could run a little higher, we have for a long time ground on the stream wet. We began to grind our meal on the stream wet when we were running straight extraction on expellers. By so doing, we could run our moisture to 12 or 13 percent.

Another advantage we found was that when we left the hammer mill and tent to the tank, it was absolutely the same temperature as outside air. To be able to put moisture into meal and ship it, you have to have it cooled. I think those two things are the biggest advantages that I would say we found in our systems.

Question: I have several thoughts here. I'd like to ask Mr. Brown, unless it is capacity-wise, how he can justify a prepress operation instead of a direct solvent one.

Mr. Brown: One reason is that we don't have enough capacity for straight solvents, so therefore, we prepress. Does that answer you?

Questioner: Yes. I have another one I'd like to throw out for anybody. Has anyone direct-extracted peanuts?

Moderator: In the Mississippi Valley we don't crush peanuts. Is there anyone from the East who crushes peanuts? I don't believe we are going to be able to answer that. Mr. Reeves, maybe you know something about that?

Mr. Reeves: No, I don't. I'd like to ask a question on solvent extraction also. Mr. Hughes or Mr. Fleming, either one, do you have a vacuum dryer on your oil past your final stripping column?

Mr. Hughes: We do not.

Mr. Fleming: We have one at the Anderson plant that we run on soybeans. We do not have a vacuum dryer on cottonseed. We do use one in the soybean plant.

Mr. Reeves: The reason I asked, I thought I would pass a little information on to you. Before we started the miscella refining in our plants, we put in a vacuum dryer and many times it prevents a surge in moisture or hexane getting through the stripper into the oil and getting the oil colorized and into the tank.

I noticed Mr. Brown said when he had his moisture in the cooker he tried to add the moisture to the head of the rolls. You think that would help you more and do you add some moisture at your rolls too?

Mr. Brown: We tried that, but we choked our rolls down so much that we started adding moisture after it went over the rolls in the conveyer and before it went to the cooker. Did that clarify it?

Mr. Reeves: Yes.

Moderator: I believe that we will all have to agree that putting through 200 tons plus--what standard do you have?

Mr. Brown: Five-high rolls.

Moderator: That is a lot of tonnage. I am like Mr. Brown; I don't believe that would stand much added moisture.

Question: I believe Mr. Hughes said to get around chewing up these flakes, he dried them to seven and a half or eight. Did I understand him right? What did you originally try and how did this help? I would think drying would make them more brittle.

Mr. Hughes: We were having trouble with the flakes shooting into the two tubes and getting down in the basket and we found when they were dried out at seven and a half or eight they stopped sticking.

Question: I'd like to ask Mr. Easley a question. If he crushes around 300 to 350 tons of cottonseed a day, why wouldn't it justify putting in a direct solvent plant?

Mr. Easley: No comment.

Question: May I ask then, what it costs on his expeller operation then?

Mr. Easley: No comment.

Question: I just thought maybe I could see what your expeller cost is, that is, maintenance on your expeller.

Mr. Easley: I don't have those figures with me. Do you mean maintenance cost on expellers?

Questioner: Yes.

Mr. Easley: I think it's around 17 or 18 cents a ton, in that range. I can't give you the exact figure on it. I might say that 18 cents per ton of cottonseed included mechanical repairs on expellers.

Moderator: I would almost challenge Mr. Easley on that 17 to 18 cents, but it's too late in the day. That appears to be too low.

Mr. Reeves: That is about right. That is what mine run.

Moderator: Mr. Smith, have you any comment on 17 or 18 cents?

Mr. Smith: I think what Mr. Easley is talking about is just expellers. He is not talking about the whole mill.

Mr. Easley: Not the whole mill, not quite.

SESSION III

John E. Covington, Chairman

ECONOMICS OF DELINTING

by
Stanley P. Clark
Texas A&M University
College Station, Tex.

We should review the changes in the price structure which have occurred in the past 18 months before discussing the economics of delinting. In table 1 are prices and cellulose adjustments for cotton linters for the last 10 years. The prices previous to the present range from twice the average price during the 10 year period. Until 1965 the adjustments for cellulose in linters above or below the 73 percent cellulose base were uniform as shown in the third column. In August 1965 the bleaching industry shifted from a uniform premium to a graduated scale of premiums. The reason for this change presumably was to encourage the production of linters of higher cellulose content.

Table 1.--Prices and cellulose adjustments for cotton linters by season

Season Aug.-July	Average price cents per lb.	Average adjustment cents per lb. per pct. cellulose
1956-57	4.38	0.06
1957-58	3.31	.04
1958-59	2.08 [1]	.03
1959-60	2.92	.05
1960-61	3.30	.05
1961-62	4.92 [2]	.08
1962-63	2.91	.07
1963-64	2.57	.06
1964-65	2.52	.06
1965-66	3.13	[3]
Jan. 1967	6.00	---

[1] Low.
[2] High.
[3] Graduated adjustments started August 1965.

Table 2 demonstrates the difference in yields and losses which could be experienced under the two premium schedules while monetary returns remained constant. The base price was set at 2.50 cents per lb., because this was the price when the graduated schedule was started, and thus both schedules were applied to this price. The set of figures in the top half of the table shows the pounds of second cut linters which must be recovered from a lint cleaner in order to maintain a constant return under the uniform premium at the adjusted prices in the second column. For example, if 75 percent cellulose is to be produced from 100 lb. of 73 percent cellulose lint, the recovery must be 95.4 lb. of 75 percent cellulose lint just to maintain the same return. If a profit is to be achieved, the recovery must be greater than 95.4 lb. Similarly the last column shows the pounds of cellulose that must be recovered. Under this schedule there was not much incentive to attempt to produce linters any higher than the base of 73 percent because losses often equaled or exceeded the allowable losses.

Table 2.--Pounds of second cut linters which will give constant returns, as a base price of 2.50 cents per pound is adjusted for increasing cellulose with uniform and with graduated adjustments

Cellulose in linters	Adjusted price	Linters	Cellulose in linters
Pct.	Cents per lb.	Lb.	Lb.
	UNIFORM ADJUSTMENT AT 0.06 CENTS PER PCT. CELLULOSE		
73	2.50	100.00	73.00
74	2.56	97.66	72.27
75	2.62	95.42	71.57
76	2.68	93.28	70.89
77	2.74	91.24	70.25
78	2.80	89.29	69.65
79	2.86	87.41	69.05
	GRADUATED ADJUSTMENT [1]		
73	2.50	100.00	73.00
74	2.57	97.35	72.04
75	2.60	94.06	70.55
76	2.77	90.32	68.64
77	2.90	86.28	66.44
78	3.05	82.03	63.98
79	3.22	77.70	61.38

[1] Graduated adjustment ranging from 0.06¢ to 0.12¢ per percent cellulose above 73 percent.

The bottom half of table 2 shows similar data with the graduated adjustment schedule. At 75 percent cellulose the necessary recovery of lint has dropped from 95.4 to 94.1 lb.

In table 3 the present premium schedule has been converted into premiums and discounts in cents per pound for each 0.1 percent increment in cellulose content of linters. The figures shown must be added to or subtracted from the base price, which at present is 6 cents per lb. For example the price for 75.2 percent cellulose linters is 6 cents + 0.264 cents = 6.264 cents per lb.

In table 4 are illustrated the effects of differing lint yields, export premiums, third cut delinting, and hulls price. The writer did not have the benefit of a lot of mill data on yields and cellulose percentages obtainable by operating in different ways. So some estimates were made which it is hoped may be somewhere close to what can actually be achieved. However, even if data had been available from one mill, they would have illustrated only general principles for any other mill. Each person concerned with deciding how a lint room is to operate must make his own calculations for his own situation.

The calculations in table 4 were made for a base price of 6 cents per pound with premiums as shown in table 3. The first column is for production of 125 pounds per ton of second cut with an assumed cellulose content of 75 percent, and delinting to a residual of 1.5 percent linters on seed. The return from sale of this lint is $7.80.

The second column is for production of 105 lb. of second cut with 78 percent cellulose to a residual of 2.5 percent. The return from sale of linters is only $7.25. The difference between 125 and 105 lb. goes into hulls and brings a return of $0.30 at a hull price of $30 per ton. Less electric power and bale covering are required, so savings of $0.06 and $0.03 can be considered to be additional returns. If this method of calculation is confusing to the reader, he can subtract these costs from the return in column 1 instead of adding them in column 2, and the difference between columns 1 and 2 will remain the same.

Other costs would be different for delinting to 2.5 and 1.5 percent residual linters.

Table 3.--Price adjustments for variations in cellulose yield from second cut linters [1]

Range in cellulose yield, pct.	Adjustment [2]	Increment in Cellulose Yield, pct.										
		0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
	Premiums and discounts in cents per pound											
80.0 through 80.9	0.20	1.400	1.420	1.440	1.460	1.480	1.500	1.520	1.540	1.560	1.580	
79.0 through 79.9	.20	1.200	1.220	1.240	1.260	1.280	1.300	1.320	1.340	1.360	1.380	
79.0 and above	.20											
78.0 through 78.9	.18	.900	.918	.936	.954	.972	.990	1.008	1.026	1.044	1.062	
77.0 through 77.9	.16	.640	.656	.672	.688	.704	.720	.736	.752	.768	.784	
76.0 through 76.9	.14	.420	.434	.448	.462	.476	.490	.504	.518	.532	.546	
75.0 through 75.9	.12	.240	.252	.264	.276	.288	.300	.312	.324	.336	.348	
74.0 through 74.9	.10	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	
73.0 through 73.9	.08	.000	.008	.016	.024	.032	.040	.048	.056	.064	.072	
73 pct. Base	Figures above 73 pct. base are premiums and below 73 pct. base are discounts											
72.1 through 73.0	0.08		0.072	0.064	0.056	0.048	0.040	0.032	0.024	0.016	0.008	0.000
71.1 through 72.0	.09		.171	.162	.153	.144	.135	.126	.117	.108	.099	.090
70.1 through 71.0	.10		.290	.280	.270	.260	.250	.240	.230	.220	.210	.200
69.1 through 70.0	.11		.429	.418	.407	.396	.385	.374	.363	.352	.341	.330
68.1 through 69.0	.12		.588	.576	.564	.552	.540	.528	.516	.504	.492	.480
67.1 through 68.0	.12		.708	.696	.684	.672	.660	.648	.636	.624	.612	.600

Example of use of table: For a base price of 6 cents per pound and linters of 75.2 percent cellulose the price per pound would be 6 cents + 0.264 cents = 6.264 cents per pound.

[1] Buckeye Cellulose Corporation, Memphis, Tenn., effective 7.27.67

[2] Adjustment is in terms of each 1 percent cellulose yield above or below 73 percent base.

Table 4.--Comparative returns for 6 cents per pound base price with graduated premium schedule under different cuts

Case 1					
Assumed line cuts and quality:					
Residual linters on seed	pct.	1.5	2.5	2.5	1.5
Second cut linters	lb.	125	105	105	105
Cellulose in second cut linters	pct.	75	78	78	78
Third cut linters	lb.	--	--	--	20
Cellulose in third cut linters	pct.	--	--	--	73
Revenue from sale of linters:					
(125 lb.) ($0.0624 per lb.)		7.80			
(105 lb.) ($0.069 per lb.)			7.25	7.25	7.25
(105 lb.) ($0.0035 per lb.) export premium				0.37	0.37
(125 lb. - 105 lb.) ($0.060 per lb.)					1.20
Revenue from increased hulls yield:					
(125 lb. - 105 lb.) ($0.015 per lb.)			0.30	0.30	--
Saving from decrease in electric power:					
used: (8.5 kw.-hr.) ($0.0065 per kw. hr.)			.06	.06	--
Saving from decrease in bagging and ties used:					
(20 lb.) ($0.86 per 600 lb.)			.03	.03	--
Total returns and savings		7.80	7.64	8.01	8.82
Case 2					
Assumed lint cuts and quality:					
Residual linters	pct.	1.5	2.5	2.5	1.5
Second cut linters	lb.	127	102	102	102
Cellulose in second cut linters	pct.	75	78	78	78
Third cut linters	lb.	--	--	--	25
Cellulose in third cut linters	pct.	--	--	--	73
Total returns and savings		7.92	7.51	7.88	8.90

such as saws, files and gummers, and repairs. However, these costs are relatively small compared with costs of power, bagging, and ties. Some costs are probably not altered by a small change in cut and thus they are in the category of fixed costs which do not enter into calculations, such as are shown in table 4. Such costs include labor, storage and handling of lint, depreciation, insurance, taxes and interest on investment.

In this analysis adequate linter capacity is assumed for delinting to 1.5 percent residual lint without reducing crushing rate. If crushing rate must be reduced in order to achieve this low residual, then other costs must be considered which are beyond the scope of this paper. Once again the point must be emphasized that each individual mill must be analyzed by itself.

The figures in columns 1 and 2 of table 4 result in a greater return for the production of 75 percent than for 78 percent cellulose. However, if conditions are favorable for sale of this lint in the export market, an export premium ranging between .25 and .50 cents per pound may be received. If a figure of .35 cents is used the production of 78 percent cellulose becomes more profitable than production of 75 percent cellulose. This condition is illustrated in column 3.

In the lower one-third of the table the returns are shown for an assumed change of 5 pounds to a total of 25 lb. difference in the relative yields of 75 and 78 percent cellulose linters. With this change, even the export premium does not bring the 78 percent cellulose return up to the 75 percent cellulose return.

These calculations demonstrate that careful determinations or estimates of the yields and the cellulose percentages that can be achieved, must be made if accurate evaluation of the most profitable operating procedures is to be found.

The conditions assumed for the fourth column of table 4 are yields of 105 pounds of 78 percent second cut and 20 pounds of 73 percent third cut linters to a residual of 1.5 percent linters on seed. Under these conditions the returns are about $1 greater than those in column 1 with the same total yield. Column 4 demonstrates the benefit to be achieved by a third cut if facilities are available to do this.

The possible effects of type of foreign matter in linters other than hull pepper were ignored in these evaluations.

The effects of present high hulls prices are demonstrated in columns 2 and 3. If more normal prices of $10 to $20 per ton were in effect, the returns from hulls would be about one-half of those shown.

Turning back to table 3, the benefit of a little added effort to push the cellulose into the next higher premium range should be pointed out. For example, the premium for 77.9 percent cellulose is .784 cents while for 78 percent cellulose it is .900 cents. This would result in added income of .22 cents per 100 pounds of lint without the possibility of export premium if the increased cellulose could be produced without excessive loss.

Calculation of the most profitable operating procedure must be repeated as often as prices change substantially. If the price should drop to the level of 2.5 cents per lb. where it was a year ago, the benefit of producing high cellulose linters would be greater than shown in table 4. The reason for this is that the premiums were a greater percentage of the lower base price. For example, a price of 6.9 cents for 78 percent cellulose linters is 15 percent greater than the base price of 6.00 cents, but the price of 3.05 cents (from table 2) is 22 percent greater than the base of 2.50 cents.

The writer wishes to acknowledge the assistance of Mr. Mack Keith of Anderson, Clayton & Co. in preparation of this paper.

DISCUSSION

Question: How do you arrive at the difference in yields for a given increase in cellulose? In other words, if you want to raise the cellulose one point, how do you figure how much loss in the lint yield it's going to take to do that?

Mr. Clark: I didn't have enough information to make any calculations on which I had any confidence. Now, I did use data that I got from the power study we made a few years ago. I made a lot of trial and error calculations, and I finally came up with some figures which were consistent with each other and a curve that gave losses versus percent cellulose in linters, but I didn't use it. I decided not to use the curve in this talk because I couldn't argue with anybody that the losses were accurate. Now, if you are interested, I will be happy to tell you how I did this, but really, I think each individual operator must determine for himself what his losses are under different operating conditions. In other words, if he has enough facilities, he goes down to 1-1/2 percent residual and weighs his production. He weighs and samples the production and has the lint analyzed for percent cellulose yield. If he wants to make a cellulose material balance, he can also weigh, sample, and analyze the tailings from the lint cleaners. Then he changes the cut and weighs, samples, and analyzes under the new conditions. After data are accumulated for two or more operating conditions, the operator can make his own calculation in a similar manner to that which is demonstrated in table 4. This is the only way I know that it can be done. I don't know if that answers your question.

Question: I just wondered if you did just have some arbitrary figures or if you made some tests. I think you have answered the question to the extent that at least I agree that it has to be calculated for every mill.

Mr. Clark: I did use arbitrary figures. If anybody has any figures to suggest in place of the ones I used, I would be very happy to hear them, because this is really not a field in which I consider myself very knowledgeable. I have done some work in the laboratory on power requirements for delinting, but when I prepared this paper, I started pretty much from a cold start. I was real happy to get some help from Mack Keith to point me in the right direction. The estimates I made are mine, however, and not Mack's.

Questioner: Well, I know Mack Keith is in the linters' sales department and he may have a little different opinion from operation people.

Mr. Clark: I think he does.

Questioner: But in that connection, we have people here from Buckeye and Hercules and I think it would be interesting to hear some comments from them as to whether this higher premium for cellulose has resulted in any better quality or higher cellulose linters coming into their plant.

Mr. Clark: I'd like to hear this too. I know some people in the audience do produce pretty high-cellulose lint and get export premiums and I think it would be interesting to have some discussion on this.

Question: I am not with Hercules or Buckeye. I am Walton Smith of Southern Cotton Oil. I'd like to ask a question in connection with the figures of the last column on table 4 in which you show where the second and third cuts were baled and sold separately. On the face of it, the figures look mighty attractive, but I'd like to hear an expression from someone who may be doing this. My question is: Is 73 percent on third-cut linters realistic, or will it be more like 67, 66, or maybe 68 percent?

Mr. Clark: Good question. I can't answer it.

Mr. Charles Montague, Jr.: I am with Buckeye. I will make one comment about the effect of premiums on yield. We have found from our actual receipts that, almost regardless of the premium schedule you put in, there are other more significant factors than cellulose premium having a bearing on the yield. Growing and harvest conditions certainly enter into it. As a matter of fact, the average yield on the line that we have received this year has been down in spite of this elevated premium program. This raises the question of whether yield would have been down more if we hadn't had a graduated premium schedule, but the facts are that yields are lower this year than they have been in some past years when we didn't have such a high premium schedule.

Mr. Clark: Mr. White, I don't want to put you on the spot, but I just wonder whether you wanted to say anything about this. I think you customarily produce fairly high-cellulose lint, is that not correct?

Mr. O. L. White: We use about 78 or 79 percent. This year it hasn't been as high as it was the last part of the season, but I believe up until about 6 weeks ago we had a 79 percent average on line. We leave about 2-1/2 percent on seed and we do a lot of recycling. We get it cleaned up.

Mr. Clark: Thank you, gentlemen.

THE PROBLEM OF PESTICIDE RESIDUES

by
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This statement is limited in scope, as I have little knowledge of pesticides and lack the technical training required for work in the field. However, from my conversation with scientists who know the pesticide field, it may be fair to say that what is known about pesticides is infinitesimal compared with what is not known.

The problem of pesticide residues reminds me of what we sometimes think but do not say about our better-halves. "We can hardly live with them, but we cannot live without them;" or to paraphrase a quotation: "Pesticides are a necessary evil."

In a talk last November, Assistant Secretary of Agriculture for International Affairs, Dorothy Jacobson, pointed out that "The current population explosion is in a large measure the product of the sharpest drop in death rates in history--resulting from scientific and medical advances and public health measures in the decades since the end of World War II." To illustrate the point she mentioned a report "That the death rate in Ceylon dropped 40 percent in 1 year as a result of the use of DDT".

Thus, pesticides are a factor in the likelihood that world population will increase by 1 billion by 1980 and may double by the year 2000. Pesticides also are vital to the production of enough food and fiber to enable the increasing number of people to live and, hopefully, to improve their living standard. As is true with many things, pesticides are positive in some respects and negative in others.

For this industry, pesticide residues in cottonseed and soybean products constitute a serious hazard. Unfortunately, or perhaps fortunately, after scientists developed some pesticides and recommendations for their uses, they perfected better methods for detecting residues. Now residues are found that originally were thought to be nonexistent. Scientists have not yet determined what happens to some of the residues in the course of processing. Neither have they established with certainty the levels at which the residues may be tolerated as "harmless."

I can best illustrate the problem of pesticide residues by discussing an incident that occurred last year.

On May 24, 1966, about noon, Fred Husbands, Executive Vice President, National Cottonseed Products Association, called from Memphis to inform us that a car of crude soybean oil had been seized by the U. S. Food and Drug Administration at Memphis because it contained endrin. The oil originated from a mill located in an area where endrin is used extensively on cotton.

The refiner was afraid to continue purchases of oil under his contract with the processor as Food and Drug might make further seizures. The processor, with a substantial inventory of beans on hand, was fearful of disastrous loss.

The situation was discussed promptly with the Administrator of Agricultural Stabilization and Conservation Service (ASCS), the Under Secretary of Agriculture, and the Associate Administrator of Agricultural Research Service (ARS). They recognized the difficulties that might be caused by the seizure. Losses to processors could be disastrous. The supplies of soybeans, soybean oil and soybean meal were relatively short. If substantial quantities of oil or beans were to be seized and kept off the market because of pesticide residues, there would be worldwide repercussions.

The situation then was explained to officials in U. S. Food and Drug Administration. This was coupled with an expression of the Department's desire to cooperate fully in establishing facts and in carrying out any appropriate corrective measures.

Members of the industry, USDA and FDA moved promptly to try to deal with the problem. Through telephone conversations and meetings, plans were evolved to bring together existing facts and to develop new information.

There were conflicting reports on presence of endrin in the seized car of oil. Tests by one commercial laboratory showed no endrin while tests by another did. New samples were drawn and tests were made by the Department. These tests confirmed the presence of endrin.

There was some evidence to indicate that refining of the oil would remove the endrin. One refiner previously had difficulty with heptachlor (another of the chloinated hydrocarbons) in a car of milo oil. After refining, heptachlor was not found in the oil. Also, analyses of samples of oil from grocery shelves had not shown pesticide residues.

The refiner who had rejected the seized car of soybean oil proposed that five cars of crude oil containing endrin be refined separately by the usual process to determine whether the endrin would be removed. The proposal was cleared with FDA. Results indicated that the endrin was removed from the oil at the deodorization stage in refining, but did not show where the endrin had gone. Questions remained, therefore, as to whether the endrin was present in some other "product" form and where it had gone. The refiner's report on these five cars became available on July 11, 1966.

In the meantime, FDA continued sampling cars of oil throughout the area but no further seizures occurred.

Also in the meantime, the processor whose one car of oil had been seized was having difficulty in selling oil. Despite all the good counsel and encouragement that Fred Husbands could give and despite my expression of confidence over several weeks that the matter would be resolved satisfactorily, the processor was in an uncomfortable and almost untenable position. It was a severe strain to wait until the near block on movement of oil from the particular plant could be removed. This strain was eased after the July report on the processing of the five cars. Actually, the seized car of oil was not released until January 1967. Then, it was processed to produce oil for use in the formulation of paint.

The industry, with approval and understanding of USDA and FDA, moved to make more thorough tests at a "pilot plant" in Louisville to determine what happens to endrin in the refining process. These tests were planned by scientists from the chemical companies manufacturing endrin, several refiners, USDA, and the National Cottonseed Products Association (NCPA). Leadership in arranging for and coordinating this study was taken by the NCPA. The report from this study was expected in September 1966, but the time required for extensive and careful laboratory tests, cross checking of results, and the writing of the report by the several participants delayed it until February 1967.

This report shows that processing removes endrin and that none of the so-called rearrangement products of endrin are present in the processed oil. The study indicates that the soap stock is free of endrin. But, this study also fails to account for the disappearance of the endrin originally present in the oil. The theory is that the endrin vaporizes under heat at the time of deodorization and disappears as a gas. Tests under controlled laboratory conditions may confirm this.

The problem of endrin (and other chlorinated hydrocarbon) residues in oil may be considered as resolved at this point. But, this is only one chapter of a book that is in the process of being written. Pesticide residues will continue to be of serious concern until more knowledge is obtained.

Let me illustrate this by questions.

Are the refining processes here and in other countries always such that the endrin (or other pesticide residues) will be removed?

Do soybeans that are used for food contain pesticide residues?

Are there residues of pesticides other than chlorinated hydrocarbons?

Are these pesticide residues in other agricultural commodities that are used for food and feed?

Do the pesticides tend to build up in the soil to be picked up later as troublesome residues in agricultural commodities?

Are the residues at levels detected thus far actually harmful to people or to livestock and poultry?

Last summer when the issue of endrin in soybean oil was so "hot," the idea was expressed that farmers should be encouraged to discontinue the use of endrin and to shift to other pesticides. A few people thought this might be done in connection with the 1966 cotton crop. It was impractical within such a short time. Aside from the time limitation, the whole issue was confused last summer. More research was needed to obtain facts upon which to base action.

There was hope that knowledge from research would afford a better basis for action in 1967. Here, the unknown looms large relative to the known. Research is directed to the finding of new facts or knowledge. This can be painfully slow. The additional facts developed thus far do not provide a satisfactory basis for general changes in recommendations for use of pesticides in 1967.

Pesticides contribute much to the public health. They are necessary for the production of food and fiber required to feed the increasing world population. In this sense, "we cannot live without them." But, the pesticides or their residues may be harmful. In this sense, "we can hardly live with them." This is especially true when an industry--soybean or cottonseed, for example--may be placed in financial jeopardy from the application of pesticides (which they cannot control) to products they buy and process. On this score, I am optimistic. Information from research should provide knowledge upon which to base appropriate action. Problems arising in the interim can be handled in a reasonable and sound manner.

DISCUSSION

Question: Who's doing the work on pesticides in oils? Is this a group project or is it confined to one specific area of the laboratory?

Mr. Thigpen: Someone may answer that question better than I can. I wonder if Garland Harper or someone who has been working on this program might want to pick up the question.

Mr. Harper: If he is referring to the study which has commonly been called the NCPA study, this is a joint study by Velsicol, Shell, and the National Cottonseed Products Association, the particular study, and the work was done at the Louisville plant, the pilot plant at Votator Division.

Question: I didn't quite follow, sir; the connection between soybean oil and endrin in a cotton-growing area. Was there a causal relationship established?

Mr. Thigpen: I'll answer on the basis of my understanding. There is uncertainty as to whether endrin was improperly applied directly to soybeans. The thinking is that it more likely was a matter of drift from the application of the endrin to cotton.

Question: I have one more question. Did I understand you to say that you didn't know whether the endrin was removed by alkali refining or deodorization or did it take both operations?

Mr. Thigpen: The endrin goes out at the deodorization stage. Now, if Keith Smith or somebody wants to correct me on this, they can, but this is what I understand the records to show today. They do not have the volume accounting for the endrin and its disappearance, and I explained the theory on that.

Question: If the endrin suspected was because of drifting from the cottonseed spraying, what injury then would the cotton grower have to fear?

Mr. Thigpen: I don't understand all that I should about this, but I believe the cottonseed oil, for some strange reason, does not show endrin to the extent that is true for soybeans.

Whether that is a matter of the endrin itself not getting onto the seed or just what, I am not certain. I wonder if someone who knows more about this than I do might like to comment further on the question. It's strange that the cottonseed people should be dealing with a soybean problem, but as an aside, I might say that this NCPA organization and some of the other cottonseed organizations have a long history of fine technical work, and I think this is another example of it.

Mr. Clark: I might make a comment on that if nobody else wants to comment on it. I don't really know anything about the subject, but I have ideas. We, at our laboratory do a lot of work for agricultural chemical people in processing small lots of seed. I say this because I'd like to point out that the people who manufacture agricultural chemicals certainly are concerned with the problem and are trying to really find out what happens.

The seeds that they send in have been treated in different ways. Now, this is on a small scale. Sometimes we get, oh, maybe 10 or 20 lb. of lint cotton and sometimes the seed comes in and sometimes the lint cotton comes in.

Anyway, depending on what form it comes in--we gin it if necessary, and then sometimes delint it, and if not delint it, why then we hull it and separate it and prepare the meal and the oil from the seed. Of course, that is all we do. We give the products back to the people that are sponsoring the work and they carry out their own analyses.

But my opinion on this matter is that probably most of the pesticides falls on the leaves of the plant, and if it gets into some open bolls, it's picked up by the lint. Then, if it should get down to the seed, it has to get through the linters and the seed coat. So there is probably not enough contact between the materials that carry the pesticide and the meats from where the meal and oil are made to get any residues into either the meal or the oil.

Chairman: May I make a comment? If the question is, why should cottonseed processors be concerned, I would point out that soybeans have become quite a large crop in the South. A great many of us who are cottonseed processors are also soybean processors.

The farmer may have a field of soybeans here and a field of cotton over here. I don't mind telling you when this thing happened that Mr. Thigpen referred to, it shook us all up considerably. It may be that we are a little apprehensive, but we do not want contamination in any respect if it can be avoided.

We do not want contamination of the cottonseed by reason of the effect of chemicals on a cotton crop. It may be, as I say, that we were a little overapprehensive, but at the same time, we wonder if it might strike us next.

Mr. Thigpen: I might ask a question myself in view of the explanation of the difference between cottonseed and soybeans. If it's a matter of the endrin being physically present or not present on the seed, I can see where your cotton leaves, the boll and the lint might keep it off, but then the soybeans are protected also in terms of being inside a hull, and I wonder if it's a question of the endrin being picked up in the plant in some manner and fed into the seed?

And out of curiosity, I wonder if there is anyone here on the scientific end of this who would like to pick up this question? Is there a probable difference between the two? There is no answer.

COTTONSEED MEAL IN SWINE AND POULTRY RATIONS

by
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Introduction

In this second year of greatly reduced cotton acreage it appears more necessary than ever to inject a little optimism into this clinic--so optimism will be theme of this talk. Already we are seeing signs of an altered cotton policywhich many of us hope will encourage growth of more top-quality cotton, eliminate the 7-million-bale stockpile of largely undesirable cotton, and put the cotton industry back in a healthy and competitive position.

Cottonseed meal has now been solidly established in the nonruminant feed market because private, university, and government research groups: (A) Developed the fundamental chemical and biological information, (B) converted it to practical application, and (C) through publications and trade associations, disseminated the information to cottonseed meal buyers.

In this paper I would like to: (A) Briefly summarize and review the production, the types and characteristics of cottonseed meal, and how the nonruminant market for cottonseed meal was opened up; (B) suggest guides to the successful use of cottonseed meal in swine and poultry rations; and (C) comment on where we should go from here.

Production Areas

Cottonseed meal is produced within the area of heaviest concentration of broilers and layers as shown in table 1. Five states--Texas, Mississippi, Arkansas, California, and Tennessee--processed more than two-thirds of the 2.8 million tons of cottonseed meal produced in 1965. The first four states produce two-thirds of the cotton harvested in the United States. Cottonseed from adjoining States is moved to Memphis for crushing into oil and meal, thus accounting for considerably more cottonseed meal than cotton production in Tennessee. Table 1 shows the relative size of the major cotton-producing States when portrayed in relation to total cottonseed meal production.

Also shown is the location of each of the approximately 180 screwpress (expeller), prepress solvent, direct solvent, and hydraulic cottonseed oil mills. Screwpressed (expeller) cottonseed meal accounts for approximately 60 percent of the total of 2.8 million tons of cottonseed meal made in 1965; direct solvent and prepress solvent meals each represent about 20 percent; and hydraulically processed meal accounts for less than 3 percent.

Characteristics of Cottonseed Meal

As all of you know, gossypol occurs in cottonseed meal in what is termed the "free", or readily extractable form, and in the "bound" state. Together these values equal "total gossypol" content. Our best information indicates that most of the "free" and a small amount of the "bound" are biologically available to the animal. You also know that total gossypol content of cottonseed meal is due in large part to effect of environment, i. e., where the cotton is grown, rather than to type of processing. Among the different types of cottonseed meal screwpressed is usually relatively high in residual oil and low in both free gossypol and protein quality. Prepress solvent meal is usually low in residual oil and free gossypol and moderate to high in protein quality. Direct solvent cottonseed meal tends to be high in protein quality, moderate in residual oil, and high in free gossypol content. Our company operates a large direct solvent plant, however, that produces, by means of a unique production step, cottonseed meal of relatively low free gossypol content.

Solubility of nitrogen in 0.02 N NaOH and determination of protein lysine with free epsilon amino groups are two of the more common methods employed to measure protein quality of cottonseed meal. It is debatable which method is superior. Convenience and lower cost of analyses have resulted in wider use of nitrogen solubility in oil mill operations, but widespread use of the epsilon amino lysine technique has been made in research fields. Probably neither method is employed as widely as it should be. Both methods can be reasonably well correlated with nonruminant response.

Lysine Supplementation

Numerous studies have shown the need to provide for adequate lysine in cottonseed-meal-containing rations for nonruminants by either blending cottonseed meal with lysine-rich proteins or by addition of L-lysine. During processing of cottonseed into meal application of excessive heat results in rendering lysine unavailable to the animal through reaction of the epsilon amino group of lysine with carbohydrates and cottonseed pigments. That lysine supplementation of low gossypol cottonseed meal can produce dramatic effects is shown in table 2. In this study average daily weight gains were increased by as much as 500 percent by supplementation with fermentation product L-lysine. Usually the better the protein quality of cottonseed meal, the less the response from L-lysine. Even though L-lysine will greatly increase weight gains, it will not protect pigs from excessive levels of free gossypol.

L-lysine additions to cottonseed meal fed to chicks have also produced excellent results as shown by the research of C. Johnston and A. B. Watts of Louisiana State University (Poultry Sci. 43:957-963, 1964).

Counteraction of Gossypol in Growing Rations

To state that reports relating poor response of nonruminant animals fed cottonseed meal to presence of a toxic level of gossypol are exceedingly numerous would

Table 1. --Area, cotton, and cottonseed meal production of major cotton States

State	Area, Percent of U. S. total land acres	Percent of U. S. Total in 1965		
		Cotton[1]	Cottonseed meal[2]	
			Calendar yr.	Fiscal yr.
Texas	8.6	31.4	27.8	28.4
Mississippi	1.5	13.5	15.2	14.7
California[3] [4]	5.1	11.4	11.4	11.4
Arkansas	1.7	9.7	10.3	9.9
Tennessee	1.3	4.2	8.4	8.6
Arizona	3.6	5.2	5.5	5.5
Georgia[5]	1.9	3.7	4.7	4.9
Alabama	1.6	5.7	4.5	4.4
Louisiana	1.5	3.8	2.9	-
South Carolina	1.0	3.3	2.6	2.8
North Carolina	1.7	1.5	2.0	2.2

[1] Cotton Production in the U.S., Crop of 1965, U.S. Department of Commerce, 1966.

[2] Cotton Production and Distribution, Bulletin 202, U.S. Department of Commerce, 1966, and Fats and Oils, Vegetable Oil Crushers, Summary for 1965, Series M20J (65)–13, U.S. Department of Commerce, 1966.

[3] Top egg (540 mil. doz.) and layer state.

[4] Second in turkey production (15 mil. birds).

[5] Top broiler (225 mil.) state.

Table 2. --Effect of Lysine on Swine Fed Cottonseed Meal[1]

Variable	Av. daily gain	Av. daily feed	Feed gain
	Pound	Pound	Pound
Cs Meal A	0.34	2.00	5.88
CMA + 0.3 pct. Lysine	1.66	5.71	3.44
CMA + 0.6 pct. Lysine	1.74	5.92	3.40
Cs Meal B	1.07	3.96	3.70
CMB + 0.3 pct. Lysine	1.61	5.63	3.49
CMB + 0.6 pct. Lysine	1.71	5.87	3.43

[1] F. Hale and C. M. Lyman, J. Animal Sci. 20: 734–736, 1961.

be an understatement. There is little doubt, however, that in many cases poor response of the animals was due to deficiency of some feed component, and in many cases available lysine was the limiting factor. Because approximately four-fifths of the cottonseed meal produced is of the low, free gossypol type and the broilers do not appear to be affected by levels of free gossypol found in practical-type rations, the gossypol problem as related to this species becomes of more academic interest. Swine, however, are sensitive to relatively low levels of free gossypol, such as 100 p. p. m. in the ration. Thus, in order to expand usage of cottonseed meal in swine and some other nonruminant rations, it is necessary to either: (a) Remove or inactivate gossypol in cottonseed meal, or (b) find a way to counteract gossypol by ration modifications.

Of course, cotton free of gossypol in the seed is under development. Because cottonseed represents only a small percentage of the value of the total cotton crop most of the cotton breeding is, of course, concentrated on factors relating to the more valuable cotton lint. After problems of fiber yield, fiber length, fiber strength, disease resistance, weather resistance, and a long list of other factors are dealt with, then the breeder gets around to breeding for glandlessness or lack of gossypol. Thus, a significant amount of high-quality glandless cottonseed is not yet available.

Removal of gossypol by solvents other than the widely used commercial hexane has been heavily researched, but the oil mills have not adopted these newer solvents. Thus, we come to the latter solution; that is, counteraction of the undesirable effects of gossypol by ration modification.

It has been known for years that gossypol effects could be counteracted by ration modifications, such as by additional protein or addition of iron salts. Additional protein made the ration too expensive, however, and supplementation with iron salts gave inconsistent results.

The National Cottonseed Products Association, operating through the NCPA Research Committee, saw the need for fundamental data to provide a sound basis for counteraction of gossypol toxicity. Determination of the metabolic fate of gossypol was a first step. Studies were conducted with rats, chicks, and swine using both C^{14} labeled and unlabeled gossypol. Results of work with swine at North Carolina State and Texas A&M are shown in table 3. With both forms of gossypol, it was found that the liver became a concentrated source of orally administered gossypol, and kidneys also displayed relatively high concentrations, but much less than liver tissue. In some studies the bile showed high levels of gossypol indicating the route of disposal of the pigment.

Iron supplementation had shown considerable promise when tested more than 50 years ago as an antidote for gossypol. When the data were reevaluated a few years ago, a logical explanation could be offered for some of the failures encountered. About 1960, it was decided to resume testing of iron salts as a means of counteracting gossypol effects. In contrast to earlier work adequate provision was made for required amino acids, vitamins, and minerals. Results of swine tests showed that not only would ferrous sulfate greatly decrease liver gossypol, as illustrated in table 3, but symptoms of gossypol toxicity, such as labored breathing, were prevented. In some trials a significant increase in weight gains and feed efficiency followed iron supplementation, as noted in table 4. The iron-cottonseed meal studies

Table 3. --Effect of orally administered gossypol on tissue concentration in swine. [1]

Tissue or fluid	Gossypol in tissues and fluids (dry matter basis)		
	C^{14} gossypol [2] (Texas A&M)	Unlabeled gossypol, (N. C. State)	
	Pct. of liver value with no suppl. iron	Pct. of liver value with	
		No suppl. iron in ration	Plus iron
Liver	100	100	34
Adrenal	29	---	--
Kidney	26	46	13
Lymph Node	20	28	9
Gall Bladder	15	--	--
Bile	15	25-146 [3]	21-125 [3]
Blood	11	10	2
Heart	9	22	12
Spleen	9	41	26
Intestinal Tract	8	--	--
Lung	7	26	19
Pancreas	6	10	6
Fat	5	--	--
Muscle	4	8 (Dia)	8 (Dia)
Skin	2	--	--
Testes	2	--	--
Urine	1	--	--
Brain	0. 5	6	6

[1] Data from C. M. Lyman. NCPA Research Committee Ann. Rpt. 1964–65; F. H. Smith and A. J. Clawson. "Effect of Diet on Accumulation of Gossypol in the Organs of Swine". J. Nutr. 87: 317–321. 1965.

[2] As measured by radioactivity.

[3] Calculated from wet weight basis.

Table 4.--Counteraction of gossypol[1] toxicity in swine by iron [2]

Protein supplements [3]	Average daily gain, kg.		kg. gain/kg. feed		Pct. of pigs without toxicity symptoms	
	-iron	+iron [1]	-iron	+iron [1]	-iron	+iron [1]
Cs meal and soybean meal	0.47	0.59	0.23	0.25	70	100
Cs meal and meat scraps	.51	.71	.25	.28	30	100
Cs meal and soybean meal and fish meal	.58	.77	.27	.30	50	100
Cs meal and fish meal	.63	.79	.27	.31	50	100

[1] Approximately 190 p.p.m. free gossypol and 400 p.p.m. iron, from 0.12 percent monohydrate ferrous sulfate, in rations.

[2] C. M. Lyman and F. Hale, Proc. Texas Nutrition Conf. 1963 and Personal Communication, 1965.

[3] All rations isonitrogenous.

included use of the highest free-gossypol cottonseed meal known in this country. The meal was fed at levels to provide free gossypol at up to at least four times the fatal dosage. Studies with several ratios of iron to free gossypol showed that a 1:1 ratio by weight of iron to free gossypol offered complete protection from gossypol symptoms as illustrated in table 5.

Among the iron salts that have been tested, ferrous sulfate, especially the monohydrate form, appears to be most desirable from the standpoint of cost, effectiveness, and compatability. Early studies showed ferric oxide was not effective.

Studies by Frank Smith and A. J. Clawson at North Carolina State have indicated that zinc and copper will not counteract gossypol. Combinations of calcium and iron salts may be more effective than only iron salts but inconsistent results have been obtained.

Cottonseed Meal for Layers

One of the most challenging problems was development of a satisfactory laying hen ration that contained significant amounts of cottonseed meal. The number of failures reported is colossal. Success was achieved by recognition that two important factors in cottonseed meal affect egg discoloration,

Table 5.--Effectiveness of iron in preventing gossypol toxicity in swine [1]

P.p.m. (mg./kg.)		Ratio	Av. daily			
Free gossypol	Iron [2]	Fe/gp	Feed	Gain	Feed gain	Deaths
In ration	In ration		Kg.	Kg.		
80	0	0	2.73	.74	3.67	0
244	0	0	2.12	.55	3.86	4
400	0	0	1.47	.39	3.78	9
80	40	0.5	2.61	.73	3.60	0
244	122	0.5	2.68	.69	3.90	0
400	200	0.5	2.52	.65	3.86	1
80	0	1	2.67	.71	3.70	0
244	244	1	2.83	.76	3.74	0
400	400	1	2.74	.75	3.64	0
Control (corn-soy meal)			2.76	.79	3.51	0

[1] A. J. Clawson and F. H. Smith. "Effect of Dietary Iron on Gossypol Toxicity and on Residues of Gossypol in Porcine Liver. J. Nutr. 89: 307–310. 1966.

[2] From monohydrate ferrous sulfate.

especially when eggs are subjected to prolonged cold storage.

The pigment gossypol, of course, plays a prominent part in olive yolk discoloration, as illustrated by the slides. Cyclopropenoid fatty acids occur in minor amounts in residual oil of cottonseed meal and can cause pink whites, salmon color and enlarged yolks, or both, and, in combination with gossypol, dark yolks. These effects are also illustrated. Successful use of cottonseed meal in layer rations thus resulted from selection of cottonseed meals with low residual oil and free gossypol. Addition of iron salts provide an additional safety factor with low gossypol meals, as shown in table 6, and permit use of meals previously restricted by too high a free gossypol content. Widespread use of cottonseed meal in layer rations by large mixed-feed companies both within and outside the United States demonstrates the effectiveness of the low oil-low gossypol-iron salt technique.

Guides to Successful Use of Cottonseed Meal in Swine and Poultry Rations

For "grower" rations, that is young swine or poultry, it is especially important to provide adequate amino acids, especially lysine, when cottonseed meal is fed. High quality fishmeal is a particularly good source of lysine. In some areas of the Cotton Belt, price of synthetic lysine has been low enough to warrant use of this source of lysine. Generally speaking, the higher the protein quality of the cottonseed meal the less the need for additional lysine. This is the reason for encouraging oil mills to produce cottonseed meal of higher protein quality.

Recently it has been shown by Carl Lyman and his associates that additional energy in a swine ration appeared to at least partly compensate for reduced protein quality. If this holds true in other experiments, and if feed fat is economically priced, it may permit greater use of lower protein quality cottonseed meals in nonruminant rations. Regardless of this it is necessary to provide for sufficient energy in rations to make the most economical use of cottonseed meal.

To counteract gossypol in swine rations, our best information indicates the need for one part, by weight, of iron from ferrous sulfate for each part of free gossypol. Lower levels of iron have been used successfully but are not recommended.

Two types of ferrous sulfate have been successfully used. Exsiccated (dry) ferrous sulfate is more expensive than the copperas type of ferrous sulfate but contains a higher percentage of iron and probably fewer impurities. Other iron compounds are not recommended.

When feeding cottonseed meal to laying hens, our best evidence indicates the need

Table 6. --Effect of monohydrate ferrous sulfate on counteraction of cottonseed meal-induced yolk discoloration [1](eggs cold stored 3 months)

Cottonseed meal				Yolk Discoloration of cottonseed meal in ration					
		Gossypol		5 pct.		10 pct.		15 pct.	
No.	Fat	Free	Total	No iron	Iron [2]	No iron	Iron [2]	No iron	Iron [2]
	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
1	1.91	.02	1.08	0	0	0	0	0	0
3	1.51	.05	0.74	0	0	0	0	0	0
6	.45	.02	0.75	0	0	0	0	0	0
2	.64	.03	0.83	0	0	0	0	4	0
8	.97	.04	0.88	0	0	0	0	12	0
9	1.25	.04	1.17	0	0	4	0	8	0
4	.88	.03	0.88	0	0	0	0	24	0
5	.88	.03	0.79	0	0	8	0	40	0
7	.53	.02	1.24	0	0	0	0	4	12

[1] Data of Kemmerer, A. R., Hewang, B. W., Vavich, M. G. and Sheehan, E. T. "Effect of Iron Sulphate on Egg Discoloration Caused by Gossypol". Poultry Sci. 44: 1389. 1965.

[2] 0.1 percent monohydrate ferrous sulfate (about 310 p.p.m. iron).

for ten parts, by weight, of iron for each part of free gossypol. In some instances it may be necessary to increase the proportion of iron to allow for unusual levels of "bound" gossypol. It is advisable to feed cottonseed meals of low residual oil content and is especially important if eggs are to be placed in storage. Soapstock containing either gossypol or cyclopropenoid fatty acids or both should not be fed to layers.

Were Do We Go From Here?

Several large feed companies are now feeding significant amounts of cottonseed meal to swine and poultry. With the present and future competition from (1) other oilseed protein supplements, (2) urea and other nonprotein, and (3) protein made from petroleum via yeast and bacteria, it is essential that cottonseed meal improve its competitive position. Many influential people have encouraged the conversion of more oilseed protein to human food to meet the great demand for energy, protein, .and functionality. Obviously to satisfy this demand we should provide cottonseed protein products essentially free of gossypol and other undesirable components. Whether this is achieved by breeding or processing is immaterial. We have now pushed down a lot of barriers. Let's finish the job.

References

In addition to the references cited, the following five publications have provided much background information for this paper:

1. Phelps, R. A. Cottonseed Meal for Poultry: From Research to Practical Application. World's Poultry Sci. J. 22(2): 86-112. 1966

2. Phelps, R. A. Enhancing the Nutritive Value of Cottonseed Meal. Feedstuffs 39(3): 32, 36, 37. 1967.

3. Phelps, R. A. Use of Iron Salts to Counteract Gossypol in Cottonseed Meal. Feedstuffs 38(18): 90, 92, 94. 1966.

4. Phelps, R. A., Shenstone, F. S., Kemmerer, A. R., and Evans, R. J. A Review of Cyclopropenoid Compounds: Biological Effects of Some Derivatives. Polutry Sci. 44(2): 358-394. 1965.

5. Proc. Conf. on Inactivation of Gossypol with Mineral Salts, New Orleans, La., Apr. 4 to 5, 1966. Natl. Cottonseed Products Association, Memphis, Tenn.

DISCUSSION

Question: I have been to this meeting and a number of others, and I always had on my mind a question which I wouldn't ask, but I want to ask it today.

I want you or somebody else in the audience to explain this particular question to a bewildered operating man. We come to these meetings and nutritionists tell us that solvent meal is higher in quality than screw-press meal, but then when we get ready to sell it, we are asked to take a discount on it. I wish somebody would explain that to me.

Richard A. Phelps: Well, I will say one thing, but I know there is somebody in here that can answer it a lot better than I can. Certainly there are areas of the country such as the West Coast where buyers are paying a premium for solvent meal.

I think you have in mind an area of the country where 60 or more percent of the cottonseed meal production is of the screw-pressed type. I would guess that if a buyer is paying a premium for this type of meal he is doing so for the oil in the meal. Many feed manufacturers in your area are probably using such a low level of cottonseed meal that it really does not make much difference if they use prepressed solvent, direct solvent, or screw-press. Some buyers prefer high oil meal for the extra energy and believe they can buy energy cheaper that way than from animal fat.

What I have been referring to is when a feeder is using 10 to 15 percent cottonseed meal in nonruminant rations. Then you start getting into an area where protein quality matters. If you are feeding only 3 percent to swine, I will concede it does not make a lot of difference. It does make a difference, however, in laying-hen rations. I think some of you are aware of the case in Mississippi where eggs from a very large number of layers became discolored when the birds were fed 3 percent of meal with probably the highest free gossypol content in the country.

But at the 3 percent level it doesn't make any difference anyway, so they are having to put 3 percent of the highest gossypol content in the country in there and when they called us, they were paying out $1,500 a week for the eggs.

I don't know whether they are buying back their own eggs, but they are buying back everybody else's that got mixed in with them. I am sorry I can't answer the question any better than that. Is Harold Wilcke in here? He could do a good job on that.

Question: Is it not true that the differential is mostly in the export market? Is it not true that solvent cottonseed meal is bringing, generally speaking, about the same price level as expeller press meals with the exception of the export market, excepting perhaps, some mills located in the cattle-feeding area?

Chairman: I can comment on this, I think it's your customer acceptance. You noticed yesterday that Mr. Brown from Pine Bluff said that when they went to the solvent extraction on their cottonseed that they didn't have any problem that they thought they would have. I think as long as we have gotten people like Dr. Phelps getting these people to accept it--they better or they are going to put us out of business with the expellers.

But, I think that is the whole thing, whether your customer accepts it. For instance, at Kosciusko, of course, we sell all we can make and all we can buy, beg and steal, right there to those people, and of course, they like that high-fat meal, but the solvent meal is actually better.

Dr. Phelps: For some uses. The important thing is to use the "right" meal for the "right" job.

Chairman: I think this is going to change. I think right now we do get a little premium for our meal over the solvent meal, maybe about $1, but I think that day is going to move on.

Question: I might agree with Mr. Covington on this customer-acceptance thing on solvent versus expeller meal. My experience in the feed business indicates that cattlemen, as I recall one old rancher in an area that I used to work in, said that "Solvent meal just won't even stick to the hulls. I can't get my cattle to eat it because they root down and root all the hulls out of the trough before they ever get any meal."

So that might be one matter. I wonder if Dr. Phelps might care to comment on a report that was given a couple of weeks ago in this City at the meeting of the Southern Agricultural Workers about the fact that some screwpress meals that had lower nitrogen solubility actually gave a little better performance for ruminants because they were retained a little longer and apparently got a little better digestibility.

There is some indication that we might end up with processing meal one way for ruminants and another for nonruminants. Any comment?

Dr. Phelps: I don't know anything about that paper, but you may be familiar with the fact that the National Cottonseed Products Association supported a project at Oklahoma State University under the direction of Dr. Tillman for a number of years. The project had the objective of finding out if we should process cottonseed meal one way for ruminants and another for nonruminants. The work was done with meals processed over a relatively wide range of nitrogen solubility, but, unfortunately, the data do not tell us exactly how to process cottonseed meal for optimum results with ruminants.

THE VALUE OF QUALITY CONTROL

by

Allen Smith
Perkins Oil Company
Memphis, Tenn.

Introduction

The Processors Clinic this year, 1967, is dedicated to the memory of Clarence F. Garner. It is my privilege to have a small part and talk to you about Quality Control. Mr. Garner knew the true value of Quality Control. His life as I knew him proves this beyond a doubt.

Discussion

In your opinion, what is Quality Control? A chemist whose duty is to compound the many components that go into making a first-grade automobile tire has this to say--"Governing the combining of specified raw materials and specified mixing procedures, to obtain that trait of excellence in our final product which will earn its acceptance to public demand, at a cost which is competitive on existing market." A president of a cottonseed oil mill has this to say--"Quality Control in oil milling, simply stated, is producing products to meet required standards, stressing continuing efficiency and maximum economy." A superintendent has this to say--"A proper or essential way of keeping within limits any product affording a standard of comparison or means of verification."

A leading question would be--Where does Quality Control really start? In reviewing some papers given here at this Clinic, Quality Control may start at different points (18) and (10). To my way of thinking Quality Control starts before you send your seed buyer out to purchase cottonseed and ends after all the products are sold and a settlement is made for your efforts and time in doing the best job possible with the raw materials on hand.

It may be assumed that you all know the Value of Quality Control. Your presence here today indicates to me that this is true. In the next 20 min. or less, let us think not so much about its value but about some of the ways that one may accomplish the most practical and profitable end results.

The guidelines set forth in previous talks here at the Clinic are most helpful. The little things when taken as a whole will amount to a sizable figure (9). Storage and careful supervision of the seed, particularly as to temperature, will pay great dividends. Quality may well be destroyed before you start actual processing (8). Figure 1 shows how a temperature record may be kept.

At our first Clinic (1952) the most pressing problem was, as is now, the cleaning of the seed and lint (13). Yet, some mills have increased their cleaning equipment as much as three times what they were using at that time. We are producing a better quality of lint today, but we are still faced with competition mentioned by Mr. Rogers at our first Clinic (13).

The first cut linters are still one of our best cleaners (19). One of the little things that can be done, inexpensively, is to place what we call a seed slide in front of and below the first cut linter. This wire slide will, if kept clean, remove from 30 to 40 percent of the short sticks, immature seed, shale and broken meat particles before the whole mass goes on to the second cut linters. It has been proved that this practice, in a buyers market, will aid in producing a salable second cut lint that otherwise would be rejectable (14). Figure 2 shows a cut of this wire slide.

Materials and Methods

The number and arrangement of linters you have may very well determine the type of lint that your mill will produce. The market and demand will determine the quantity, or that amount you leave on the black seed. The amount of first cut with respect to the amount of second-cut lint will be, in most cases, regulated to fit the price for first-cut compared to the price of second-cut lint.

The quality of second-cut lint, that is the percent cellulose content, will depend on several factors:

(a) The price that depends on demand and supply.
(b) The amount of cleaning equipment available.
(c) The premium and discount rate, 73 percent cellulose.

There is another paper being given on delinting. It is hoped that the overlap in content if any, will be at a minimum. However, mention has been made as to cellulose content and the cleaning of second-cut lint. Cellulose content is directly connected to cleaning. The price also is associated with cleaning. The question to consider next is how much cleaning will be profitable with respect to the actual pounds of lint we ship to the pulp plant. In other words, how much cleaning may be done at a profit?

Figure 3 was calculated by using the Cellulose Yield Adjustment chart - Schedule 3-A. This chart gives the premium and

PERKINS OIL COMPANY

FAN HRS.
✓

HOUSE # M
DATE: 12-13-66

STATION	CABLE	SWITCH 1	DIAL No. 2	USE DIAL	TEMPERATURE READING POINTS (° F.)																		
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	AV.
1	B	A	1	#3	72	66	61	64	58	77	80	63	57	54	59	52	53	64					
	M	A	2	#3	67	66	57	58	75	59	53	52	51	52	54	52	52	52	58				
	T	A	3	#3	67	58	59	72	80	73	64	76	57	57	64	69	76	57	77	59	55	56	
2	B	A	4	#3	67	68	79	79	78	78	62	56	56	53	76	73	55	55					
	M	A	5	#3	46	38	42	41	47	40	35	36	38	37	36	39	67	58	56				
	T	A	6	#3	78	62	62	67	70	64	68	74	62	62	58	55	74	75	68	56	69	69	
3	B	A	7	#4	77	75	79	72	72	72	73	73	63	53	74	77	60	74					
	M	A	8	#4	52	56	╳	60	56	60	58	64	59	61	60	59	54	62	55				
	T	A	9	#4	72	71	69	69	70	64	63	61	63	74	68	64	62	56	55	75	75	56	
4	B	A	10	#4	69	69	76	75	75	75	75	75	75	75	60	╳	72	60					
	M	A	11	#4	71	69	79	74	76	78	79	77	78	72	65	58	51	70	62				
	T	A	12	#4	68	60	62	66	68	71	72	72	72	74	71	59	55	51	51	71	76	56	
5	B	A	13	#5	68	59	55	62	75	75	74	73	74	67	53	47	74	63					
	M	A	14	#5	42	52	47	49	53	53	61	49	49	49	70	62	50	46	46				
	T	A	15	#5	58	73	71	52	52	52	53	58	63	67	53	51	50	53	75	79	77	62	
6	B	A	16	#5	52	66	57	71	52	73	72	62	59	53	51	68	57	71					
	M	A	17	#5	69	55	55	╳	79	39	53	59	52	53	45	67	75	59	64				
	T	A	18	#5	54	54	54	74	48	59	59	59	72	68	54	65	67	65	58	55	╳	╳	
7	B	B	1	#6	╳	╳	72	╳	╳	53	72	60	53	75	╳	╳	╳	╳					
	M	B	2	#6	43	57	58	41	42	50	54	54	54	53	55	76	76	57	56				
	T	B	3	#6	54	57	62	66	76	73	67	60	59	66	73	68	73	73	67	68	69	55	
8	B	B	4	#6	59	70	70	54	61	72	72	72	72	68	58	52	66	60					
	M	B	5	#6	69	83	89	64	67	74	73	75	74	71	62	55	53	75	62				
	T	B	6	#6	57	57	60	72	74	54	53	54	61	73	62	56	52	54	75	76	75	56	
9	B	B	7	#7	77	68	57	48	57	64	70	71	77	75	63	56	77	60					
	M	B	8	#7	55	62	75	67	54	55	57	74	74	74	74	66	61	60	60				
	T	B	9	#7	╳	╳	69	73	74	67	54	56	73	71	66	62	61	61	61	57	74	65	
10	B	B	10	#7	48	51	69	54	52	52	64	64	62	54	42	49	54	47					
	M	B	11	#7	60	61	72	78	56	56	61	70	66	64	61	57	72	74	60				
	T	B	12	#7	52	52	53	57	67	72	60	52	59	73	60	56	52	59	73	70	63	55	
11	B	B	13	#8	61	74	78	58	60	71	75	72	68	64	53	48	73	54					
	M	B	14	#8	48	74	74	54	52	57	47	65	63	53	53	48	61	65	55				
	T	B	15	#8	╳	╳	╳	╳	╳	╳	╳	╳	╳	╳	╳	╳	╳	╳	╳	╳	67	54	
12	B	B	16	#8	53	69	48	54	68	73	54	57	62	60	50	74	57	50					
	M	B	17	#8	53	64	73	54	53	57	66	54	50	51	52	50	72	67	54				
	T	B	18	#8	55	53	45	59	54	54	54	52	69	53	64	74	58	66	74	65	53	50	
13	B	C	1	#9	61	61	63	75	76	76	73	62	58	60	61	52	54	52					
	M	C	2	#9	55	51	52	48	46	50	48	49	50	50	50	51	51	53	51				
	T	C	3	#9	51	51	49	50	56	52	52	52	50	50	╳	54	54	54	54	54	53	51	

Grand Average Temperature of Seed - - - - - - - - - TIME

WEATHER CONDITIONS

Start 8:20

RAIN - - - - - CLOUDY - - ✓ - - - FAIR - - - - -

Finish 9:10

RELATIVE HUMIDITY: HIGH ____ % LOW ____ %

OPERATOR Smith

TEMPERATURE: HIGH ____ TIME ____

SUPT. ____

LOW ____ TIME ____

Note: All switches must be "off" except those in use.

Figure 1. -- Temperature record

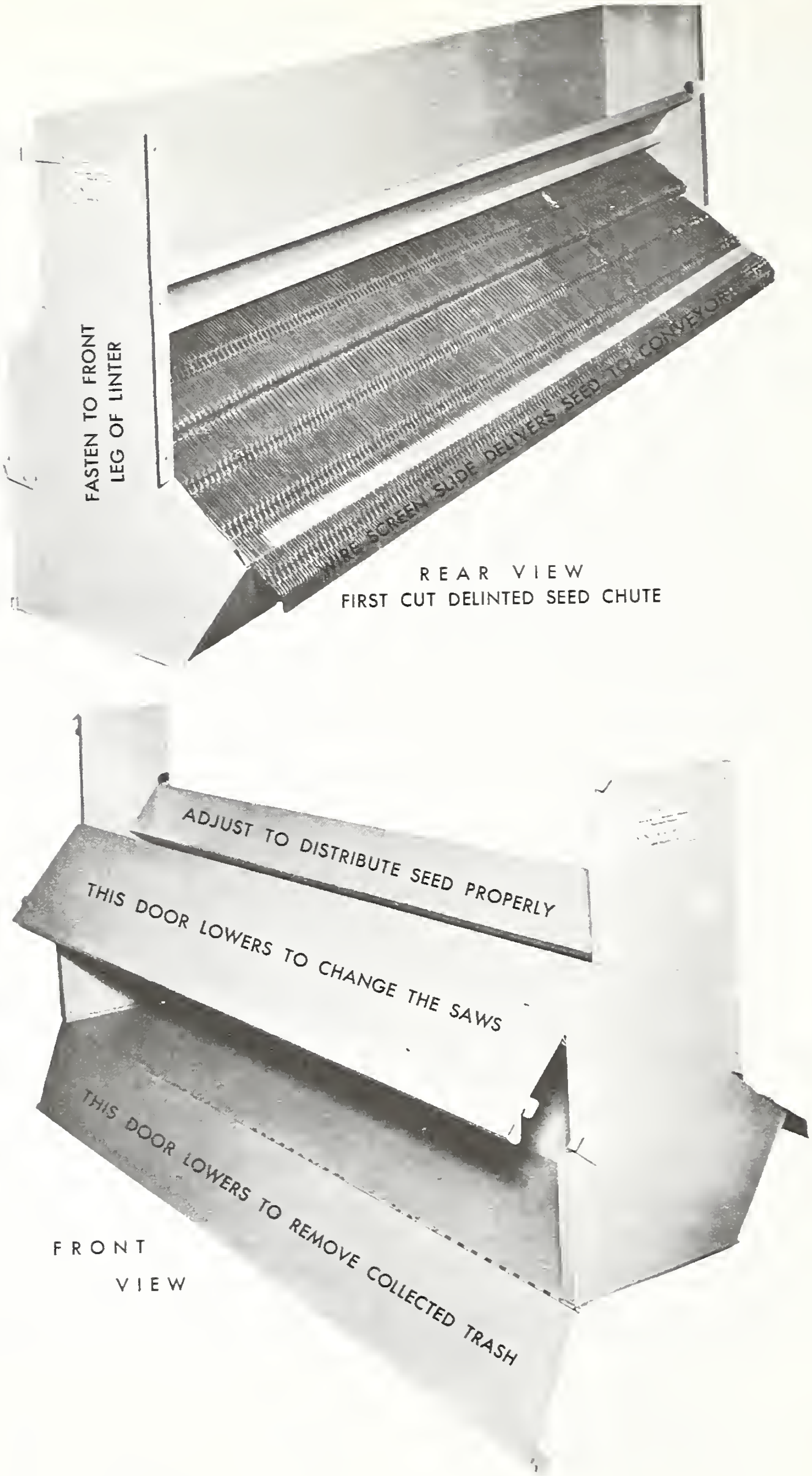
FASTEN TO FRONT LEG OF LINTER
WIRE SCREEN SLIDE DELIVERS SEED TO CONVEYOR
REAR VIEW
FIRST CUT DELINTED SEED CHUTE
ADJUST TO DISTRIBUTE SEED PROPERLY
THIS DOOR LOWERS TO CHANGE THE SAWS
THIS DOOR LOWERS TO REMOVE COLLECTED TRASH
FRONT VIEW

Figure 2.—First-cut delintered seed shute.

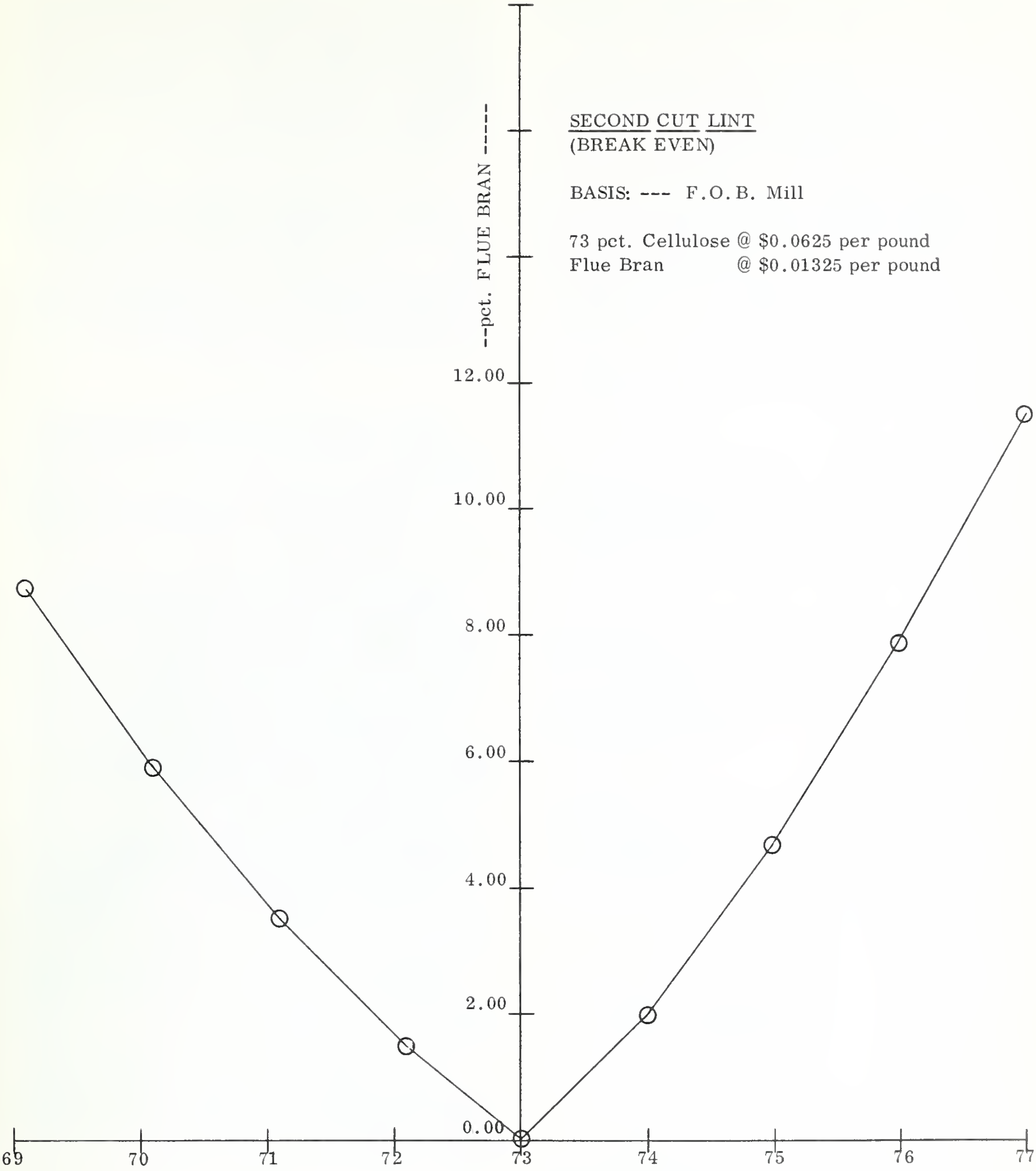

Figure 3.--Percent cellulose in second-cut lint.

discount for lint, above and below 73 percent cellulose. A base price of $0.0625 was used, f.o.b. mill. Note: No charges were made for the cost of actual cleaning, only the weight loss was used. Sample calculation for determining the break even point for cleaning second-cut lint is shown below:

65,000 pounds, weight of lint in test run
65,000 times $0.0625 = $4,062.50, value of lint, if sold as 73 percent
Let X = pounds of 74 percent after cleaning.
Let Y = pounds of flue bran removed by cleaning.

X + Y = 65,000
X = 65,000 - Y

We know:

(65,000 - Y) times the price of 74 percent cellulose lint plus Y times the price of flue bran will be equal to the 73 percent cellulose.

Therefore:

(65,000 - Y) $0.0625 + $0.01325 Y = $4,062.50
$0.05025 Y = 65.00
Y = 1,293.53
X = 63,706.47

X+Y = $65,000.00

$\frac{1,293.53 \text{ X } 100}{65,000}$ = 1.99 percent flue bran removed.

63,706.47 X $0.0635 = $4,045.36
1,293.53 X $0.01325 = 17.14

Cleaned lint plus flue bran - - - - $4,062.50

In calculating the break-even point, credit was given to the mill for the flue bran and other foreign matter removed at the rate of $0.01325 per pound (bulk). By inspection, if your cleaning equipment is efficient to the point that it is possible to raise the cellulose content, say, from 73 to 74 percent and not beat out more than 2.0 percent of the original weight of lint then the cleaning is profitable. If you try to raise the cellulose content from 74 to 77 percent, you are limited not only as to the amount that you lose in weight, from 2.0 percent to 11.5 percent--approximately 9.5 percent--but the efficiency of the beater has to be considered. Clean lint, no foreign matter, will run 82.5 to 84.5 percent cellulose (5).

Another point to consider is, what is to be done with the extra amount of short fiber removed in raising the cellulose to this high level? Too much lint used in reducing the protein in oil cake will be objectionable in the meal. Likewise, too much of this material in the hulls will be objectionable.

Suggestions

(a) Determine the amount of uncleaned lint going to the lint beater and its cellulose content.
(b) Clean the lint to a moderate degree and weigh the amount of flue bran removed.
(c) Determine the weight and cellulose content of the cleaned lint.
(d) The weight of flue bran and the weight of cleaned lint will be the weight of uncleaned lint, before beating.
(e) From the figures, calculate the percent by weight of the flue bran removed.
(f) Consult previously mentioned chart and if the amount of flue bran is less than shown and you can live with the flue bran either in the meal or hulls, then the cleaning operation is profitable.
(g) Repeat the above procedure until the point of diminishing return is reached.
(h) Lessen the amount of cleaning to a point so that amount of flue bran is less than shown on the previously mentioned chart.

Operating a lint room is expensive but necessary (1). The above check points may help lessen the total cost.

Many papers have been given by able speakers here at this Clinic, covering hulling and separation (7), conditioning and rolling (3), cooking and pressing (4).

Review

Previously, your speaker has talked about the quality of crude oil and how, in his opinion, its refining loss may be effected by moisture and temperature (15). With others, he has discussed hidden oil loss (2, 11, p. 34, 41-42, 18).

The subject is once again mentioned because we believe that some more light has come to the surface. In screw pressing, it may not be practical to produce the highest quality of crude when refining loss is the only yardstick by which we measure this product. In this context, quality control may be explained as receiving the greatest net returns for a standard product when compared to a like standard product manufactured under different procedure.

The residual oil or oillike substance in cottonseed meal, as reported by the present analytical method, may not be indicative of the true value for which we are searching (11).

It has been demonstrated at our mill in Memphis, that by varying the degree of tempering and conditioning the meats before cooking will change the relative percent refining loss (16).

One method that may be used in comparing one crude oil with another of different free fatty acid content is by using a factor that we call an "X" value. The "X" value is arrived at by subtracting from the percent refining loss the product of three times the free fatty acid content. Normally, an oil having an "X" value of 2.5 will refine, by cup method, producing a smooth hard soap stock at room temperature. A soap stock of this nature will contain 5 to 6 percent neutral oil by the Wesson method. An oil having an "X" value as high as 5 may, and usually does, contain as much as 10 to 12 percent neutral oil. An oil with an "X" value of 1 or less will contain 5 percent and less of neutral oil. These figures were obtained by test in our laboratory. It has also been observed that an oil having an "X" value of 3.5 and higher will produce an oily rough soap stock. Usually this is an indication that a hard cook, less moisture and steam in the top kettle, was employed in its production. Conversely, an excess amount of moisture and steam in the top kettle will produce an oil having a lower refining loss and correspondingly low "X" value. This is true when compared to similar seed condition as used in above statement.

However, caution should be exercised as to how low to go with the "X" value (15). This is a theory, but it seems to be true. When a mill operates around the limits 2.5 to 3.0 for an "X" value the annual material balance, actual figures, will agree within 1 percent of the calculated oil yield.

Table 1 shows by calculations many combinations of processing practices that may be used in the pressroom. The base set of conditions: 3.2 percent residual oil in meal and an oil having an "X" value of 4.5 are actual operating conditions in an oil mill for this season. The others are calculated figures using 2.5 as an "X" value for the oil and comparing the net value in premium paid for the higher quality oil produced. It is logical to assume that a mill may lower its "X" value from 4.5 to 2.5 and make a profit providing that the residual oil in meal does not increase more than from 3.2 percent to above 3.7 percent.

On the subject of protein control of meal shipments, I suggest you review a very good paper by Quinn (12) and also another paper by Mr. Fowler (6).

Conclusion

There are so many points to cover on the subject of "The Value of Quality Control" that one person, in 20 min., is at a loss when he tries to choose or not to choose those points which are worth your while and attention.

Finally, it may be stated that quality control is a valuable tool to the processor and, if diligently practiced, will materially aid in the manufacture of a standard product at the least expense.

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1. Brawner, J. H. 1955, The Importance of Increased Economy and Efficiency in Delinting Cottonseed. Fourth Cottonseed Processing Clinic, pp. 41-43.
2. Brawner, J. H. 1957. Hidden Oil Loss. Sixth Cottonseed Processing Clinic, p. 42.
3. Dunning, J. W. 1952. What are the Effects and Quality of Products (Discussion). First Cottonseed Processing Clinic, p. 46.
4. Fincher, H. D. 1960. How to Cook Cottonseed Meats for Best Results. Ninth Cottonseed Processing Clinic, pp. 10-13.

Table 1. --Net premium return showing relationship of residual oil in meal to "X" value of crude

Meal shipments		Oil recovery	Crude oil "X" value	Net premium from one ton seed	Net premium increase or decrease
Residual oil, pct.	Standard				
	Pct.	Pct.		$	Pct.
3.2	40	91.24	4.5	0.29	0
3.3	41.4	91.01	2.5	.89	(+) 207
3.4	42.6	90.76	2.5	.72	(+) 148
3.5	43.9	90.52	2.5	.61	(+) 110
3.6	45.1	90.28	2.5	.50	(+) 72
3.7	46.4	90.04	2.5	.39	(+) 34
3.8	47.6	89.80	2.5	.28	(-) 3.4

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17. Smith, Walton. 1957. Hidden Oil Loss. Sixth Cottonseed Processing Clinic, p. 37.

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19. Taylor, Dick. 1952. First Cotton Processing Clinic, p. 42.

DISCUSSION

Question: Do you cook for the lowest refining loss at the West Memphis Plant and the Perkins Plant in Memphis? If so, what is your hidden oil loss?

Mr. Smith: If you will review some of the literature that I have mentioned, you will find that we do not cook for the lowest possible "X" value, that is, lowest refining loss. We tried to balance the refining loss against our residual oil. We make a crude oil having a refining loss with an "X" value = 2.5--by that I mean, if your free-fatty acid is one percent and your refining loss is 5.5, then you have an oil X value of 2.5. It's just that simple. Now, don't go lower than that, because it is my opinion that if you go much lower than two with your "X" value, your hidden oil loss is going up. To answer you directly, with respect to the hidden oil loss, it has varied. Some years our final yield has been as high as 3 lb.; but usually it's less than that and sometimes the hidden oil loss will be as high as 4 lb. per ton.

Incidentally, we just finished our crush at West Memphis. How much oil do you have in the storage tank, Charlie? (No response.)

Charlie is our superintendent over there. We will be something like 1-1/4 percent short of the calculated yield unless the weight of oil in our tanks increases above estimated amount. The inventory is calculated by using so many pounds per inch in those tanks. Normally, we gain in weight, so I hope that it will be true this year and our hidden oil loss will be less than what it indicates today. Does that answer your question?

Questioner: I think it is fairly well answered; but one thing--what has your experience been before you realized that you had to operate on quality control as far as shooting for the very possible lowest refining loss compared to this hidden oil in the years past?

Mr. Smith: How far do you want to go back?

Questioner: Have you ever had any back disappointments as far as the hidden oil loss by making this real fine oil?

Mr. Smith: I just said that we do not try to make a refined crude oil, or as high quality as you might. That's possibly due to this--and I think you are trying to get me to tell all these people that 1 year when we were processing crude oil and we thought we knew it all, we were even telling the French how to operate the screw presses and we were adding water in the top kettle. The amount that we added was limited to the opening in the top kettle down to the second kettle. We added so much water that the meats wouldn't go through the opening. Then we cut down a little on the water and shipped out crude oil that had an "X" value of one, less in many instances. The sad part about it was that at the end of that year we had a hidden oil loss of over 12 pounds per ton.

Questioner: Thank you. That was it.

Mr. Smith: I thought you were trying to make me say that. That's been brought out in previous talks so I didn't mention it today.

Question: I think you've already gotton around to what I was going to ask you, but would you mind going through the gymnastics on how you arrived at an X value?

Mr. Smith: It is very simple. You take your percent of refining loss, whatever that may be, and subtract the product of three times the free-fatty acid content. In other words, if you have a crude oil that runs a 1 percent free-fatty acid and the refining loss is 5.5 , then you have an oil with an "X" value of what I call 2.5.

Question: That is three times the fatty acid then?

Mr. Smith: This system is not unique in my practice, because other people have different factors and Lawrence Hodges could tell you more about the factor he uses.

Question: It's a common belief among most superintendents I think, that it's not practical to lint down too much below 2 percent, say from 2 percent to 1-1/2. Do you have any substantiating figures on that? Any data as to whether or not it is economical? I am talking about your cost, labor, power, and source; in other words, delinting down below 2 percent with normal capacity in your lintroom.

Mr. Smith: I do not, but Mr. Woodyard and R. D. Long are back there, and John Howard has done a lot of work on that. The way we operate--we run as high a protein through the pressroom as possible. If we have good, fat seed, we can get down to 1.5. 1.25 or 1.75 lint on the delinted seed. Then, as the seeds become poor, if we get into a bunch of seed that has less meats with ratio to the hull content--in other words, bad seed--we keep our pressroom going. We have to do one of three things. We have to leave more lint on the seed and get more volume through the lint room, cut out one of the screw presses, or you can put a bunch of hulls in your meats and keep all presses going. The best thing is to have plenty of linters and then you won't be worried. You can go down to 1.5 percent. Mr. Verdery may have some figures on that.

COMPETITION OF AMMONIA AND UREA WITH COTTONSEED MEAL IN FEEDS FOR RUMINANTS

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The demand for high-protein feeds has been increasing rapidly over the past 10 years. This increased demand has been evident in both quantity and price. Cottonseed meal, however, has not benefited from this increased demand as much as soybean meal. This is because cottonseed meal is a byproduct of a crop grown under acreage-control which restricts production. Those interested in selling cottonseed meal have been able to share in the greater demand only to the extent that prices have increased.

Figure 1 shows how the use of natural protein feeds has increased over the past 25 years. It also shows that the use of cottonseed meal has not increased very much. The predominate increase has been in the use of soybean meal, and as a result, cottonseed meal has been a smaller and smaller percentage of total natural high-protein feeds. This decline has taken place gradually over the past 25 years.

Figure 2 shows the use of cottonseed meal in feed consumed by the various types of livestock. You will note that the quantity fed to dairy cattle and beef cattle has declined slightly despite the fact that the number of beef cattle has increased. Cottonseed meal fed to hogs has not changed very much over the past 25 years. The quantity of cottonseed meal fed to poultry has increased steadily in the past 5 years. Still, poultry consumed only about 15 percent of the cottonseed meal fed in 1965. Another 13 percent was consumed by hogs.

The expanding use of cottonseed meal in poultry rations really began about 1957. In 1959, 400,000 tons were used for poultry feed. This represents a fourfold increase over the tonnage used before 1957. Until that time little change had occurred over a 15-year period. Most of the recent increase probably was in feed for laying hens rather than for broilers.

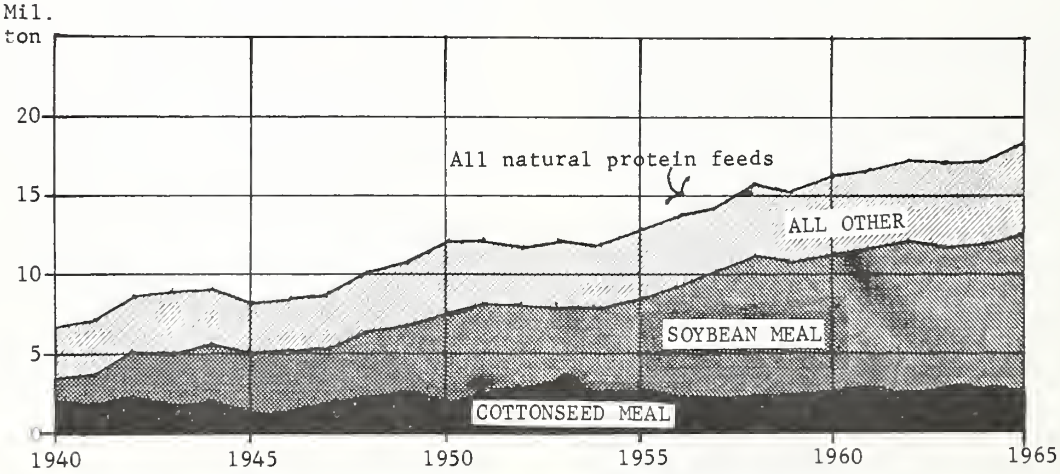

Figure 1.--Consumption of natural high protein feeds.

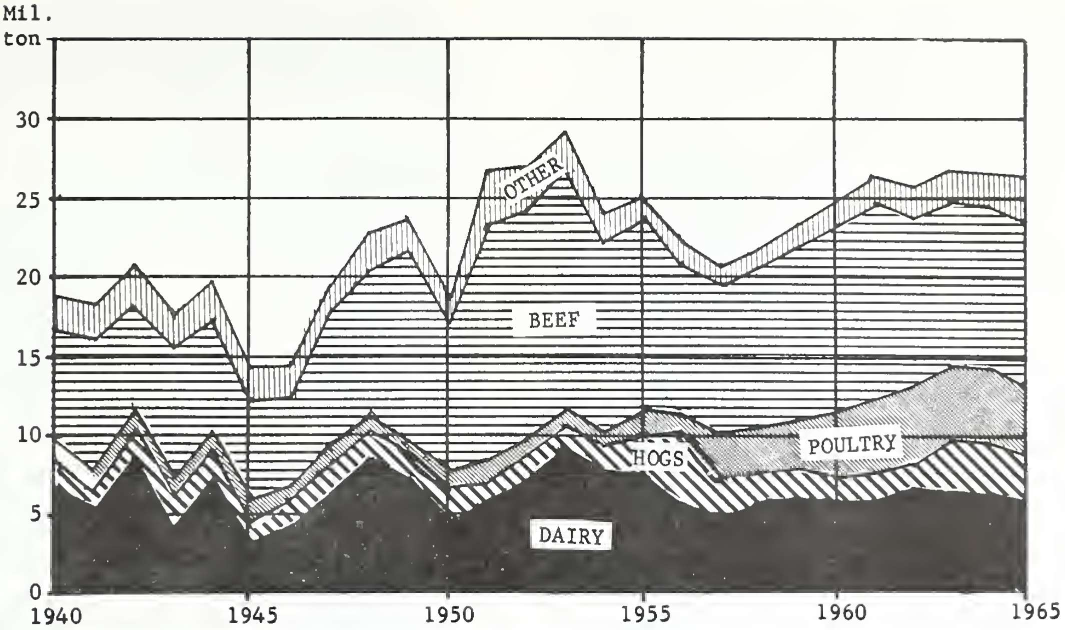

Figure 2.--Consumption of cottonseed meal by livestock.

Table 1 shows the rapid increase in the use of urea in feed. These estimates may be low because regular fertilizer urea can be, and is, used for feed. While fertilizer urea may require more care in mixing, it is generally cheaper than the feed-grade and is higher in nitrogen content. As you probably know, urea contains nitrogen which must be converted to protein by micro-organisms in the rumen, and hence, is not utilized by chickens or hogs. While it may be toxic even to cattle when not properly used, the feeding of urea is not a problem in modern cattle feeding establishments where the urea is mixed well with concentrates such as corn, sorghum, or molasses. Many firms sell a protein concentrate for cattle that is basically urea and molasses. A few specialized firms market a liquid protein supplement and nothing else.

Table 1. --High protein feeds fed to cattle and sheep and sales of feed-grade urea

Year	High proteins	Feed-grade urea sales (Soybean meal equivalent)
	1,000 tons	1,000 tons
1955-56	3,711	350
1956-57	3,762	382
1957-58	4,015	433
1958-59	4,303	475
1959-60	4,585	555
1960-61	4,869	630
1961-62	5,190	670
1962-63	5,605	760 1/

1/ Preliminary.

The use of feed urea in 1955 was estimated to be equivalent to 350,000 tons of soybean meal. It was 760,000 tons in 1963. It can be seen from table 1 that the rate of increase is faster than that of all natural high proteins.

The prices of oilmeals have been edging upward the past 10 years. They have risen at a much higher rate than those of grains. Hence, feeders have tried to decrease costs by substituting other feeds and using the most expensive ingredient more parsimoniously.

The former has been done by using urea; the latter by checking the precise lysine and other amino acid content of the protein supplement and furnishing the livestock with only their minimum requirements. As can be seen by looking at table 2, the prices of corn and sorghum have not changed very much since 1956, while prices of the chief oilmeals have increased.

A comparison of the costs between oilmeal protein supplements and urea feed supplements shows why many feedlot operators have turned to using urea. In table 3 the

Table 2. --Prices of corn, sorghum, and the oilmeals

Year	Corn [1]	Sorghum grain [1]	Soybean meal 44 percent protein [2] Decatur	Cottonseed meal 41 percent protein [2] Memphis
	Dollars per bu.	Dollars per cwt.	Dollars per ton	Dollars per ton
1956	1.29	2.05	47.45	51.70
1957	1.11	1.74	53.40	56.50
1958	1.12	1.78	55.80	59.45
1959	1.04	1.53	55.55	56.25
1960	1.05	1.49	60.60	56.15
1961	1.00	1.80	63.60	59.20
1962	1.10	1.82	71.30	66.90
1963	1.12	1.74	71.00	62.20
1964	1.11	1.88	70.20	59.80
1965	1.17	1.79	81.50	72.40
1966	1.16	1.80 [3]	83.65	75.30

[1] 1956–1957, Agricultural Statistics, 1966.
1958–1959, Feed Situation–214, p. 23, June 1966.
1960–1966, Agricultural Prices, 1965 Annual Summary and Revisions for Corn Agricultural Prices; Feed Market News, October to December 1966.

[2] 1956–1958, Feed Situation–213, p. 29, April 1966.
1959–1965, Feed Situation, November 1966; January through November 1966, computed from weekly prices Feed Situation, 1966; December 1966, Feed Market News.

[3] Sorghum, 1966, Agricultural Prices, estimated.

Table 3. --Comparative cost per ton of grain-urea mixtures and cottonseed meal

Year	Sorghum-urea mixture [1]	Cottonseed meal 41 percent protein Memphis	Difference
	Dollars	Dollars	Dollars
1956	52.41	51.70	-0.71
1957	47.09	56.50	9.41
1958	47.78	59.45	11.67
1959	43.49	56.25	12.76
1960	42.80	56.15	13.35
1961	48.12	59.20	11.08
1962	48.46	66.90	18.44
1963	47.09	62.20	15.11
1964	49.49	59.80	10.31
1965	47.95	72.40	24.45
1966	48.12	75.30	27.18

[1] Based on a mixture of 1715 pounds of sorghum and 285 pounds of urea at 5 cents per pound. Includes grinding cost at 15 cents per hundredweight.

cost of a sorghum-urea mixture consisting of six parts sorghum to one part urea is shown in column one. The second column shows the price of cottonseed meal at Memphis. The last column shows the difference in cost per ton of the two supplements. Notice that in the last few years the difference in favor of the urea mixture has become larger and larger, particularly in 1965 and in 1966.

The difference in costs of using urea supplements and natural sources represents as much as what used to be regarded as the margin for feeding cattle.

Many large feedlot operators have switched completely to urea. A number have not used any other source of protein for three years or more. Exactly how many custom lots have switched entirely to urea is hard to determine, because this has become a bargaining point between the custom feeder and the ranchers who furnish the cattle.

The prices of urea have declined in the last 4 years; thus making its use more favorable. In 1960, the price of urea was $98 to $100 per ton. By 1965 it had decreased to about $95 and probably could be purchased for less in some areas. The cost of urea may decrease more rapidly as new plants are established. A large proportion of the price is transportation, which can be reduced as plants are built in the feeding areas. Production costs have also been reduced. The capacity to produce ammonia, one of the chief raw materials of urea, has increased rapidly in the last 3 years. Prospects are that the capacity will increase much more in the next few years. Estimates of the trade indicate that by 1969, the capacity to produce urea will be almost six times that of 1959 (table 4).

Table 4. --Synthetic ammonia end uses (estimated NH_3)

Item	1959-60	1964-65	1969-70 (estimated)
	1,000 tons	1,000 tons	1,000 tons
Urea	320	810	1,700
Ammonium phosphates	120	550	2,000

Prospects are that the production of ammonium phosphate--another source of protein for cattle--will be nearly 20 times that of 1959.

What can we conclude from these figures regarding the competition of urea and ammonia with the oilmeals? To me it is very evident that the use of urea and ammonia compounds will increase because they have been shown to compare favorably, when properly used in cattle feeds, with the oilmeals as sources of proteins. They are less expensive. Prospects are that they will become even less so in the future. If urea and ammonia displaces part of the oilmeals in cattle feeds, the oilmeals will be more plentiful for other uses. The supply could depress prices if additional exports or domestic demands are not developed. This would put cottonseed oilmeal at a distinct disadvantage as compared to soybean oilmeal unless cottonseed meal can be used more widely in poultry and swine feeds. The result could be a wider spread between the prices of cottonseed meal and soybean meal. To processors this offers the opportunity of making cottonseed meal more acceptable for poultry and swine feeds and perhaps even for human consumption. For example, iron compounds can be mixed with cottonseed meal to make it more suitable for swine. This is done now by only a very few processors. Perhaps some of the new processes for removing the gossypol from cottonseed meal could be used if the margin between the price of soybean meal and cottonseed meal would warrant it.

DISCUSSION

Question: You can't feed the urea to the chickens and hogs, can you?

R. V. Baumann: No.

Question: That's one good thing. How about this ammonium phosphate? What is that? That's a new one on me.

R. V. Baumann: Well, when you ask me what that is--I think there are a lot of chemists here who can tell you a lot more about it. It is just a compound that includes a source of nitrogen.

Question: Can you feed it to hogs?

R. V. Baumann: You can't feed it to hogs and chickens as a source of protein because they are not ruminants. Hogs and chickens don't have the capacity to make protein from the nitrogen in ammonium phosphate.

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